Proceedings of the Second Roads, Rails and the Environment Workshop

April 9-10, 1997
Revelstoke, British Columbia

Parks Canada, Banff National Park, Alberta
Columbia Mountains Institute of Applied Ecology, Revelstoke, British Columbia

Edited by: Anthony P. Clevenger & Kelly Wells

CONTENTS

John Woods

Preface

The ecological integrity of the Rocky Mountain Cordillera is becoming increasingly eroded from transportation links, development and other human impacts. The Rocky, Purcell and Selkirk Mountains in British Columbia and Alberta are particularly vulnerable to transportation-related disturbances. They are traversed by the high-speed Trans-Canada Highway (TCH) and the Canadian Pacific Railway (CPR); both make up a formidable transportation corridor whose impact on the environment, terrestrial and aquatic, is long-lasting and irreparable. The direct and indirect effects of all these activities on the environment are extremely problematic, controversial, and nothing short of catastrophic.

During the second *Roads, Rails and the Environment* workshop we addressed three key themes critical for harmonizing biological conservation and transportation needs: 1) Research, monitoring and modelling for mitigating transportation impacts on wildlife; 2) transportation-related wildlife mortality and performance evaluations of measures to reduce it; and 3) means of improving the quality of information used to make decisions regarding transportation effects on the environment. Like the first workshop in 1996, we brought together people from the many diverse disciplines, to learn about work carried out in the three aforementioned areas and generate healthy discussion around them.

A curious blend of biologists, planners, engineers and administrators from transportation and natural resource agencies, consulting firms, and NGO's spent a day and a half together in Revelstoke. We spoke about current and future projects, shared experiences, heard about ways of improving communication and networking - all for better balancing resource protection and transportation needs. We focused primarily on the Trans-Canada transportation corridor from Kananaskis Country in Alberta to Salmon Arm, B.C., encompassing the Rocky and Columbia Mountains. Presentations from adjacent areas in Kootenay and Jasper National Parks were also given. We were fortunate to have the participation of our U.S. colleague from neighboring Washington State, to make the workshop international and more importantly stress the importance of thinking transboundary.

We tape-recorded the workshop sessions to have an account of the information presented in addition to the productive question-and-answer period following each talk. The tapes were tediously transcribed to a word-processing document where later some minor changes were made to each text in order to improve their "readability". We took this approach rather than requesting from each speaker a prepared manuscript with accompanying figures and tables. This we feared would take much more time and require constant prodding to receive all the papers before the end of the millenium.

We hope the proceedings will be of use to all those working or interested in this fascinating and challenging area meshing conservation biology and civil engineering. We are confident that the workshop served to expand the margins of our traditional ways of thinking and has been a starting point for more cooperation on a regional scale. Finally, the active involvement of the participants undoubtedly guaranteed the success of the workshop.

Anthony P Clevenger
Kelly Wells

Acknowledgements

The workshop would not have taken place if the Columbia Mountains Institute of Applied Ecology didn't volunteer to host it. Their not-for-profit philosophy of organizing workshops is admirable, for keeping things simple, registration fees down and thereby allowing greater participation, particularly from students. We appreciate the help of Zak Callaway transcribing tapes and the contributors for their cooperation and patience while we prepared the proceedings. A big thanks to Peter Poole for providing us all with a stimulating and thought-provoking dinner-time talk. There are also many people to be thanked for their help in organizing and making sure the workshop ran smoothly. Mas Matsushita ensured flawless audio-visual support. Janice Hooge and Margaret Pacaud provided administrative assistance. MacKenzie Station took care of all the catering. Lastly, the workshop would not have gotten off the ground without the work of Kelly Stalker in taking care of the many details that are required to successfully put on a gathering of this type.

SESSION 1.

Research, monitoring and modelling for mitigating transportation impacts on wildlife

Assessing the impact of the Trans-Canada Highway and the Canadian Pacific Railway on bear movements and habitat use patterns in the Beaver Valley, British Columbia

Robin Munro

University of British Columbia
Box 2271
Revelstoke, B.C. V0E 2S0
E-mail: robin@unixg.ubc.ca

Keywords: Beaver Valley, black bear, Canadian Pacific Railway, impact assessment, logistic regression, Trans-Canada Highway, Ursus americanus, wildlife mortality

Abstract

Studies assessing the impacts of roads on large mammals have focused mainly on unpaved or low-traffic volume roads as opposed to those with high-speed traffic and high traffic volumes. Information on railway impacts is scarcer still. Work was conducted in the Beaver River Valley, in Glacier National Park, B.C. Black bears were captured, radio-marked and movements monitored daily. Logistic regression was used to identify site attributes used by bears. The study investigates whether the Trans-Canada Highway (TCH) and Canadian Pacific Railway (CPR) are barriers to bear movements. A crossing index was formulated by plotting sequential radiolocations. The TCH and CP Railway may be a mortality sink for bears as high numbers of bears are killed on both. During the last three years, 17 bears were killed within this relatively small study area. This suggests that the TCH and CPR are sinks. Final results from this work will be presented at the next Roads, Rails and the Environment meeting.

Introduction

The title of my presentation today is assessing the impact of the Trans-Canada Highway (TCH) and the Canadian Pacific Railway (CPR) on bear movements and habitat use patterns in the Beaver Valley (BV). It's kind of a long-winded title, but I guess what I'm really interested in is do these structures, the CPR and the TCH, impact bears? Now, I'm going to restrict my talk today to the black bear. I'm also interested in how these structures impact grizzly bears but I'm going to focus today on the black bear. I was hoping to present results, but for some reason or another I'm still in the analysis stage of my thesis so I don't have any results today. What I thought I would do is introduce the problem, give a brief description of the study site, and then present ideas on how I approach answering the big question by breaking it down into some of its key component questions. Then I thought I'd review some of the methodology I plan on using to answer the questions.

Now, when it comes to assessing the impacts of roads on bears, there have been several studies done. However, all to date have been concerned with relatively low traffic volume roads; roads with less than 300 cars/day. This pales in comparison to the TCH. As you know, it can have upwards of 8,000 cars/day and in addition, this traffic is constant and it's pretty much year-round. When it comes to assessing the impacts of railways on animals, I've managed to find very little material on it, none of which talks about the impacts on bears.

There's lots of ways in which roads and railways can exert their effects on bears. This slide shows some of these effects and their end result. On the left-hand side we've got the bear's disturbance, habitat lost, and all these result in the displacement of the individuals. On the other side we've got collisions, poaching and attractants and all these result in mortality. Now, if we were to stop at this level of displacement and mortality, we'd only be seeing part of the picture, the impact on the individuals. What we really need to know is whether the impacts at the individual level affects the population. Ultimately at the population level, it will determine whether the species survives or goes extinct. All my questions that I pose address this level. To answer the population question it usually requires a much longer study outside the scope of a Master's degree.

Study area

The Beaver River valley is located in Glacier National Park, which in turn is found in the eastern portion of the province. It runs in a north-south direction 40 km in length. If we focus in on this yellow box here it will show why this valley is of interest to me. We've got the Selkirk Mountains, Purcell Mountain range on the right and the BV divide which divides the two mountain ranges. The TCH travels through a pass in the Selkirk Mountains and down into the BV and transects the river and divides the valley basically into two portions. The northern portion not only contains the highway but actually two CPR lines and the lower portion over here, is basically untouched except for the small hiking trail which runs up its length. To give you a clearer picture of what it actually looks like, this is looking northwards. You can see this is the highway here running along and then crosses the BV. You can see on the hillside two CPR lines and the southern portion looks like this. So, if you travel down into the Beaver one thing you may notice are these right-of-ways (ROW). Sometimes, they're fairly extensive like this one here.

If you actually examine these ROW's closely, the majority of the plant species found are clover, dandelions and grasses. The reason for that is when the highway was built back in 1962, they seeded the ROW's with this clover mixture. The reason for that is they're good primary successional species. The dandelions weren't actually seeded but they are good colonizers and have since colonized these areas. But not only are they primary successional species, other researchers have noted they are important spring foods for bears because they are usually at their highest nutrient quality and they are some of the first species to green up. So, consequently, if you drive along the highway, you may see one of these bears foraging along the ROW. It attracts tourists and you often get "bear jams".

If you go up on the tracks, you'll also find associated with it, these extensive ROWs. This is particularly true of the MacDonald line and the ROWs are also seeded with the grass and clover mixture to stabilize the embankments, however bears like them too. There's an additional variable associated with the railway that isn't associated with the highway - the grain. You'll see a pile of grain like this one that comes from railway cars but more commonly what you'll see is this constant sprinkle all along the tracks. It's primarily wheat, sometimes we see flax but most of it was wheat kernels. We know some bears are keying in on it because we have direct evidence of it and other times we actually see the bear. This bear is licking up something on the tracks. We also have seen them on those grain piles and the bears are totally oblivious to the world around them.

Key questions and methodology

I will now move on to my key component questions. I'm breaking down the big question of whether or not the TCH and CPR impact bears into key component questions.
We know some bears use areas next to highways and railways but the question is, is this a common occurrence or rare event? So, I posed the first question to try and get at this issue of displacement. Do bears use areas adjacent to the TCH and CPR as often as they use areas away from them? Does the use of these areas vary between the sexes?

To answer these questions you first have to radiocollar some animals and in order to radiocollar them you need to catch them. When and where we could, we used culvert traps but more often because of the inaccessibility of our study site, we used leg-hold snares. This is what we call a "cubby", a snare is attached to a center tree. One end is attached to the tree and the other is partially hidden under the ground. The idea is to trap the bear in this area. He steps into the leg hold trap and there's a spring mechanism that cinches the snare around the bear's paw. So, once you've caught the bear... this is my supervisor, Bruce McLellan trying to drug the bear with a jab stick... you use the drug Telazol to immobilize the bears. Once they're drugged, we put radiocollars on them. This box here is the transmitter and each collar has a unique frequency so that you can track individual bear movements. In order to track them we use aerial and ground telemetry. The aerial telemetry was done on a weekly basis. The ground telemetry was done on a daily basis and because of the inaccessibility of the area we were restricted to one, maybe two bear locations a day.

Once you get this location data you need to select a habitat use study design. So I chose a site-attribute design comparing site characteristics of habitats used by the bear. Then the idea is to use logistic regression to pick out the different combinations of variables that are associated with the sites used. For this logistic regression, the dependent variable is whether the site is used and the independent variables can be many and varied. For my purposes, I chose habitat type and divided them up into what I consider are important bear habitat types (slide paths, timber, burns). I also chose to look at elevation and distance to the TCH and CPR. That's my first question.

My second question looks more at this issue of bear movement, whether the TCH and CPR act as barriers to bear movement. So, I pose the question, does the TCH and CPR act as barriers to bear movement? Is there different movement in different corridors and does movement differ between the sexes? To answer this question is actually a simple procedure involving developing a TCH-CPR crossing index. It involved plotting each bear's radio location sequentially and connecting them with a line segment then tallying the number of times the line segment crosses one of these corridors. Then you get a crossing index. Because not every bear has the same number of telemetry locations, I have to divide the number of crosses by the number of locations for each bear.

Finally, I wanted to get at this issue of mortality. I'm interested in, does the TCH or CPR act as a mortality sink? To do this, one way is to look at radio locations of all collared bear moralities. This bear was one of our sub-adult males killed by the train. This was a bear that was often seen feeding on ROW's both on the TCH and CPR. We actually thought he would be killed on the highway. In total, if you look at all our bear mortalities to date it looks like this (Table 1). The highway is zero, the railway has taken two, one female and one male and interestingly enough, two females have died of natural causes. One died of apparently old age. There was

one hunter kill outside the park and one “unknown” mortality. At the end of the 1996 tracking season, we had a total of 27 collared bears that use the Beaver Valley. I was going to mention this unknown bear. Although it’s unknown, it might have been the highway though we can’t be certain. It was found only 75m from the highway. By the time we got to him he was too badly decomposed to tell. Because we don’t know, we had to put him in the unknown category.

An additional source for mortality records is using CPR and old Park records. These are the mortality observations by Pat Wells who is a train engineer that works for CPR (Table 2). He travels from Field to Revelstoke every other day or so. On his own initiative he’s tabulated all the animals he’s seen killed. If you look at my study site we’ve had a total of 11 bears killed and majority were in the spring. We’re talking about a strip of track 15 km in length. It’s quite a high proportion in relatively small area. When it comes to the highway mortalities this is what it looks like (Table 3). This highway mortality comes from Parks Canada personnel that patrol the highway between Mt. Revelstoke and Glacier National Park. What they found in the last three years is a total of four bears killed. All these bears, both highway and Pat Wells’ bears were unmarked. So, the total is 15 + 2 research bears, that’s 17 bears in three years in a relatively small strip of habitat. So, is it a mortality sink? We don’t know what’s going on with the population but it definitely suggests it could be. I hope by the end of the summer I should have most of my results and maybe by the next Roads, Rails and the Environment meeting, I can present some of those results.

Question and Answer:

Q: Were any of the mortalities collared bears?
A: Yes, we had two railway mortalities.

Q: You talk about roads and railways being barriers to movement but the opposite hypothesis is they prefer these areas.
A: Yes, I hope in my analysis, I’ll be able to tease those apart and I may find that they actually do prefer these areas.

Q: Did you use the southern area where there were no roads or railways as a control area
A: We do have a few bears collared there now. I think there’s seven now. So that is the plan to compare the two areas

Q: The grain appears to have a lot of potential to attract a lot of different types of wildlife species. Two questions.... Did you see a lot of other animals killed that were attracted to the grain? And my other question is anybody studying the toxicity of ingesting the hydrocarbons that get on the grain?
A: We didn’t see a lot of other animals. Birds we see feeding along the tracks. I never saw a dead bird up there. We saw a skunk and porcupine but I don’t know if they’re being drawn in by the grain. As far as toxicity, I would be concerned just because it is so oily and the grain is heavily coated in it. It’s completely coated with grease from the train.

Q: Can you tell if the population in the southern area is different from the population where the highway and railway are?
A: No, we did do a DNA analysis. Michael Proctor was doing an undergraduate degree on the possibility of sampling a population using the DNA technique. So we set up the Beaver Valley

as a way to explore this. Out of that it was too hard to say. There weren't enough bears basically, so for the total numbers for the Valley he calculated 33. The confidence intervals were very broad and inconclusive. But we did have more bears in the northern portion.

Q: What was the accuracy of the telemetry you were using?
A: The accuracy for aerial telemetry was about 150m^2. The accuracy for ground telemetry was a bit worse because the valley is so steep and access in only gained through the highway and railway. Once you went past these structures it was very, very steep. It was a bit inaccurate that way, but in the middle of the valley where bears spend most of their time, the accuracy that I tested was between 50m and 75m.

Q: Have you been looking at the differences in impact collision between the daytime and nighttime and relating this to the effect of headlights?
A: Yes, I was actually interested in that too. But it's hard to get the time of day the bears were killed. In the nighttime bears may be more prone, but Pat seems to think they often get hit during the day. What he did say is he thinks a few of them are getting hit on the McDonald line going downhill. The train's quiet going downhill and the bears might not hear them. I know being up on the tracks myself, even though my senses aren't as keen as a bear's, a couple of times I was surprised that the train was coming. We had time to get off but it was a shock.

Q: How are you going to handle that you may be dealing with a group of bears that are used to the facilities, that get out of the way, as opposed to bears that come from somewhere else and aren't used to it?
A: That's a good question. It's not an easy issue but we have to provide areas for the bears to cross without getting hit. There are some places like that where the train is actually on stilts above the ground. We've actually had bears hit on the tracks in these areas because they're walking along the tracks. That's a good question. I don't know.
--You could look at the home ranges of the bears.
--Yes, some of the females we have collared in the valley are fairly old. The youngest is seven and the oldest is 20 so we could incorporate the age thing.

Q: Do you see specific areas where bears are going out onto the highways or tracks?
A: We didn't get enough crosses to actually tease it apart.

Table 1. Mortality of radio-collared bears, 1994-1996.

Highway (TCH)	0
Railway (CPR)	2
Natural	2
Hunter	1
Unknown	1
TOTAL	6

Table 2. Railway mortality observations by Pat Wells (CPR main-line, Golden to Revelstoke)

	1994	1995	1996	Total
In study area	10	1	0	11
In Park	10	1	1	12
Outside Park	3	3	2	8
TOTAL				20

Table 3. Highway mortality observations (Revelstoke to east boundary of Glacier NP)

	1994	1995	1996	Total
In study area	2	1	1	4
In Park	3	1	2	6
Outside Park	1	2	2	5
TOTAL				11

Black bear movements and survival in the Bow Valley of Banff National Park, Alberta

Rob Serrouya

University of British Columbia
270-2357 Main Mall
Vancouver, B.C. V6T 1Z4
E-mail: serrouya@unixg.ubc.ca

Keywords: Banff National Park, black bear, Bow Valley, crossing index, DNA, survival, Trans-Canada Highway, Ursus americanus, wildlife mortality

Abstract

The Bow Valley of Banff National Park contains a major transportation corridor which includes the Trans-Canada Highway, Canadian Pacific Railway, and the 1A scenic highway. These linear developments have the potential to fragment habitats and populations; they are also a source of direct mortality in terms of vehicle-wildlife collisions. This project examines the effects that different linear features have on black bears by testing the following hypotheses: (1) black bear crossing rates differ among different linear features; (2) crossing rates differ when compared to the spatial simulations of a null model; (3) crossing rates differ when compared to the simulations of a habitat specific model. We are also using DNA fingerprinting to obtain a minimum estimate of bears in the Bow Valley; this data will be used to relate mortality figures to the minimum number of bears present.

Introduction

The title of my talk is black bear movements and survival in the Bow Valley. The talk I present today is going to start with a brief introduction and is essentially split into three components: a movements component which is by and large the greatest focus of my thesis and then I will move on to the genetic and survival components.

My first slide shows the central Canadian Rockies Ecosystem which is 40,000 km^2. Banff National Park (BNP) is this area here which encompasses about 6,500 km^2. The central Rockies Ecosystem includes national parks of Banff, Jasper, Kootenay, as well as provincial parks and other provincial territories. The east gate of BNP contains a relatively low proportion of low elevation, highly productive, montane habitat. These low elevation valleys are where a lot of human activity takes place, like development and transportation corridors. In this valley we have the Trans-Canada Highway (TCH), the Canadian Pacific Railway (CPR) and the 1-A scenic highway. Again, I'd like you to notice the high elevation areas. In fact, BNP is 37% high elevation rock and ice, which is unsuitable for most forms of wildlife.

Roads, as Robin has pointed out, have direct and indirect effects on wildlife. Directly, roads can have an effect on populations in terms of road-kills. Roads also increase hunter and poaching access to wildlife in provincial lands. These things are easier to measure than the indirect effects. By indirect I mean fragmentation which is the division of a landscape which

was once formerly connected by causing urban development, resource extraction, etc. In turn, these things can lead to avoidance behavior by some animals, which can result in habitat loss. Then you can have the opposite effect, which is attraction. As Robin said, you have increased sunlight penetration, which makes for good vegetation, particularly alongside the 1-A. You tend to see animals being attracted to this road. In turn, this can lead to habituation causing bears to become used to humans. They lose their natural fear, and then they eventually become problems and have to be removed from the system because they pose a safety threat.

To mitigate some of these effects, we have underpasses along the BNP portion of the TCH. I won't go into material about the underpasses because I know there are several other talks which will be addressing this issue. Black bears do use these on occasion, more often than grizzly bears, which virtually don't use them at all. And there are also the overpasses located in the section currently being twinned. We have no records of animals crossing these structures yet as they are still under construction. However they should be completed by the end of the season.

Hypotheses

I first became interested in black bears a couple of years ago when I started doing some research on mortality figures. Especially when you relate these mortality numbers to population size. In the late 1980's there was a habitat study done in the Bow Valley and they estimated the population size at 15-18 individuals. It's a bit higher than that right now but no more than 20 adults are in the Bow Valley. So, with this in mind I developed some hypotheses. The first hypothesis is with respect to movements. Basically, the hypothesis states that there is no difference in black bear movements, that is crossing rates, when you compare the TCH and the 1-A to the Bow River which is a natural linear feature. I developed a crossing index which takes into account the proportion of road type (TCH or 1A) that exists in the animal's home range. In BNP there's certain short falls because habitat is so variable, especially the habitat adjacent to the TCH compared to that adjacent to the 1-A. The background of these treatments differs quite remarkably. The TCH differs along its route going from 2-lane to 4-lane.

The next step is to test the hypothesis that there is no difference in crossing rates between black bear movements and that of a simulated null model. What do I mean by a null model? If this is the home range of the real bear then the simulation of the null model will be bound by the identical home range. It will also use the same distance between points and the same number of points that were derived from the empirical bear. And finally, it will move in a random azimuth or compass bearing. If you run this simulation a number of times you get a distribution so you get a crossing index distribution along a particular length of road type. So let's say this distribution is for that segment of TCH that lies within that animal's home range. Let's say these hash marks here represent 95% of the variance of this distribution. If the point of the empirical bears' lies outside this interval you have what is called a significant difference. If it lies within the distribution then there is no difference.

What if it's not crossing the highway because the habitat is lousy on the other side? I'm examining this final question by testing my telemetry data against a habitat model derived in the late 80's by John Kansas and some other researchers who developed a black bear habitat quality model in the Bow Valley. I used simulations again but this time making it habitat specific by pretending that the highway wasn't there and letting the bear move freely more often to the

optimal habitats and less often to the less optimal habitats. Again, you'll get a distribution and test your empirical data. So the hypothesis is that black bear crossing rates do not differ with that of a simulated habitat explicit model.

Methodology

How do we get this movement data? You have to collar black bears unfortunately. We trap them 90% of the time using culvert traps because of the accessibility. Currently, we have 11 bears collared in BNP and last year was the first year of this study. We had a full season of telemetry data on only two of the bears because they were collared from a previous study. 1997 will be the second and final year of the project.

Genetic component

The second portion of my study is the genetic component and the objective is to get a more recent minimum estimate of the population in the Bow Valley. The secondary objective is to contribute to a larger western Canadian database. The hypothesis is that the population is not low relative to other montane populations in western Canada. Some of you are probably familiar with this technique that was developed right here in Revelstoke. It involves hanging up a scent attractant like fish fertilizer, animal fat and oats to retain moisture. You string up barbed wire about knee height off the ground. When the bear comes to investigate, they either jump over or slither under and a snag of hair gets caught. From the hair you can extract DNA from the roots. Here's a barb and here's a snag of hair that got caught on the barb.

This overhead here shows the 14 sites I had distributed throughout the Bow Valley from the East Gate up to Lake Louise with seven on each side of the TCH. So, I extracted the DNA here in Revelstoke. Unfortunately, the lab is backed up and we haven't been able to do the gels yet. I don't have genetic results of my individuals to show you today. Those should be done some time during the summer. I can show you the capture data. We did three rounds at each of the 14 sites, each round lasting 10 days. After every 10-day period, we came along and freshened up the bait and collected the hair. In the first round, we had two sites with hair samples giving a 14% success rate. We had the same success rate in the second round. In the third round, we collected hair at 10 sites for a 71% success rate giving a total of 105 samples. As I mentioned, these samples should be analyzed some time this summer.

Survival component

That brings me to the final component, the survival component. The objective is to derive maximum mortality rates for black bears. The hypothesis is black bears aren't suffering high levels of unnatural mortality relative to other montane populations in western Canada. Achieving this objective relies heavily on the genetic component to obtain a minimum estimate of bears in the Bow Valley. We had two possible estimators, one from the hair capture and one from the physical capture.

1996 was a record year for highway mortalities and the way we get this data is by driving the highway and from wardens and the public. When the animal is hit, it's picked up and brought to the abattoir for a necropsy. This data summarizes mortality. The sources are highway, railway, destruction for management purposes, removal and hunting kills for animals outside

the Park. This table includes research and non-collared animals. So, in 1996 we had four animals hit on the highway, one on the CPR and one collared animal which was hunted while outside the park. No collared animals were killed on the highway or railway this year. One female was hit quite badly on the highway but she bedded down for three days and recovered.

Plans for this summer include some light trapping the valley bottom, some DNA scent stations, continued telemetry and thesis write-up which should be completed some time in the spring of 1998. I hope to present my results to Roads, Rails, and the Environment next year.

Question and Answer:

Q: I was just wondering whether you or Robin have any idea as to what is the total population of bears in your study areas?
A: That's a really hard thing to get at. We've talked and talked about this to get an idea of spatial mortality and relate that to population size. What if all the animals were hit on the road and there's no more to be hit. Maybe mortality has gone down because there are no more animals to be hit. Your first question, yes, the early 80's estimate was 15-18. I don't suspect it's changed much. Maybe, it's a little higher but I haven't done as rigorous analysis as they did because they trapped for three years. But I'm going to incorporate the DNA data to figure out these rates. My numbers are a lot lower than Robin's but we know there are a lot fewer bears. Presenting absolute numbers is totally meaningless unless you have a population size. Other researchers strongly suspect the population is a mortality sink. I developed a simple population model and it showed that even under optimal conditions the population was declining. More animals were dying than could possibly be produced. The population is likely being maintained by immigration.

Q: Do you have a handle on reproductive rates?
A: No, getting at those kinds of demographics is something for long term studies.

Q: Is there a difference between the sexes with regards to mortality?
A: This year, if I remember correctly, all mortalities were males with one exception. This would make sense since males tend to move more. They tend to cross the highway more than females do. As far as getting at the question that Robin was asked, whether the experienced bears are getting hit less, one way to do that is to look at mortality of sub-adults. Unfortunately, I wasn't able to collar any sub-adults because they're difficult to collar, but this year we have radio transmittered ear-tags so we can get an idea of differential age mortality. As was mentioned earlier, experience plays a role.

Q: How many trains per day travel along the CPR track?
A: Good question.
Robin: In my area it was 15 trains per day on each track so 30 per day in total.

Q: You mentioned sections in your study area are fenced and unfenced. Do these preclude access by animals?
A: They seem to preclude some animals like ungulates and wolves. Grizzly bears, it seems to work for although if they want to they can lift up the fence. Unfortunately, black bears have the ability to climb. There are wooden posts used for the fences and apparently when I asked the same question to the guy in Florida (Gary Evink) he said black bears don't cross because most

of the fenced sections there have barbed wire on top. Occasionally bears in BNP cross the fence which can be a real mess because they get caught in the right-of-way.

Q: Is any of this research done outside the Park or is it strictly the Bow Corridor?
A: For me, it's strictly the Bow Corridor but the interesting things about these spatial simulations is I can apply this to anywhere there is black bear research where black bears overlap the highway. Now, I'm doing these simulations to past years data. Robin and I are discussing on doing it to her data as well.

Q: Is there any record of mortality along the 1-A highway?
A: It's very sparse, if any at all. The speeds are reduced and traffic is quite a bit lower. However, that bear that I mentioned was on a small section of road from the 1-A to the TCH at Castle Junction. It's an important data point even though she wasn't killed. The road is only about 800 m long.

Mitigation and monitoring of wildlife movements along the Trans-Canada corridor in Banff National Park, Alberta

Anthony P. Clevenger

Wildlife Section
Banff National Park
Box 900, Banff, Alberta, T0L 0C0
E-mail: tony_clevenger@pch.gc.ca

Keywords: Banff National Park, crossing structures, fencing, highway mitigation, Trans-Canada Highway, wildlife mortality

Abstract

Summarized is highway-related mortality of wildlife on the Trans-Canada Highway (TCH) in Banff National Park (BNP) during the last 15 years. Over this period, traffic volumes have increased steadily and frequent highway upgrades were necessary. Since 1986, 27 kms of TCH has been twinned (expanded from 2 to 4 lanes) and another 18 km twinning project is currently underway. Mitigation measures such as wildlife crossing structures and fencing were built into the highway upgrades. Crossing structure monitoring since 1995 has shown high through-passage rates for ungulates and carnivores; however, frequency of use is five times greater for ungulates compared to carnivores; coyotes (75%) and wolves (9%) account for nearly all carnivore use. Measures have been 94-97% effective in reducing ungulate mortality on the TCH two years post-twinning and 83-100% effective during the last 10 years. Carnivore mortality (coyote, black bear, wolf) has increased since twinning. Reasons for this can be attributed to defects in the fence.

Introduction

A cumulative effects study has shown that highway-related mortality is the greatest threat to maintaining viable wildlife populations in Banff National Park (BNP). For some species highway related mortality is extremely high. For coyotes, 25-30% of the population is killed each year, while for black bears and wolves roughly 10-20%. These losses when added to losses from collisions with trains, management removals, hunting outside park boundaries, and natural mortality, add up to mortality rates equal to or greater than rates of hunted populations outside the Park. Ironically, the Park should serve as a core refugia and source population for replenishing these unprotected, peripheral populations. At this rate it's not doing so.

The Trans-Canada Highway (TCH) brings high speed and high traffic volume into the Park. It is undoubtedly the most important transportation corridor in the country and one of the busiest highways as well. In the last 10 years traffic volumes have been increasing steadily in BNP and with that highway upgrade projects have been necessary. The first twinning (2-4 lanes) project began in 1980 at the east gate and covered 27 km (Phase I and II). There's currently an 18-km twinning project underway which will be finished this fall (Phase IIIA). The remaining 30 kms to the B.C. border, rumor has it, will be twinned in the next 5-10 years.

To minimize the adverse effects of highways on wildlife, mitigation measures can been built into these sections of highway. These measures consist of wildlife crossing structures (overpasses or underpasses). The function of crossing structures are to get animals safely over or under the highway and more importantly, to maintain habitat connectivity. The latter is needed to maintain population connectivity by allowing natural movement patterns, dispersal, recolonization of areas and allow adequate genetic interchange. Wildlife exclusion fencing serves to keep animals off the right-of-way (ROW) and at the same time direct animals to the crossing structures. Monitoring and performance evaluations are essential for determining the effectiveness of these structures, for making recommendations for improvements if they're not meeting their goals, and for being pro-active in future upgrade projects by designing more effective measures.

TCH mitigation in Banff National Park

There are currently 11 crossing structures in BNP along the 27 km of Phase I and II of the TCH. One other structure is located out at the Castle Jct. interchange. We are currently monitoring these structures. We want to know are they being used? By what species? How frequently? And how might we improve them for wildlife use?

We're quantifying wildlife visits and through-passages by two means. Raked tracking sections underneath each underpass are checked at 3-day intervals for wildlife tracks. At some underpasses we have installed infra-red-operated 35mm cameras to photo-detect animal activity. The cameras work fairly well except when it gets below -15° or -20°C the camera doesn't function. Otherwise, they take fairly good pictures. The structures have been monitored nearly continuously since December 1994 to the present.

In slightly more than two years of monitoring some interesting patterns can be seen (Table 1). The passage rates for ungulates is high, 85-95% of visits resulted in passage. The low figure for moose is a result of a small sample size, just two. One time the moose went through, the other time it didn't. The passage rates for carnivores is also high, 85-95%.

When you look at the frequency of use there's a completely different picture (Table 1). Ungulates account for five times more use of the underpasses than carnivores. That's obviously related to density and abundance throughout the TCH corridor. Among carnivores, coyotes account for 75% of the usage, while wolves account for 10%. The other carnivores do not use the underpasses regularly. During this 2-year period, grizzly bears have used the designated wildlife underpasses only once. In the western portion of the study area at 5 Mile bridge there's a radio-collared adult male that opts to cross the highway using this large span bridge underpass even though there are wildlife underpasses within 500 m on both sides of the bridge.

The Eastern Slope Grizzly Bear Project, which has been ongoing on for 3 years is finding that the TCH is a barrier for radio-collared adult female grizzlies. Their home ranges abut the TCH but do not cross it. I know John Woods has found the same thing occurring for adult female grizzlies in this part of B.C. However, I believe this is the first year a radio-collared adult female grizzly has crossed the TCH in the Western Slope study area. In other parts of the Eastern Slope study area, adult grizzlies, females included, are crossing other important 2-lane highways such as Highway 40 in Kananaskis Country and Highway 93.

We started a study this winter that was a follow-up to a work done from 1989 to 1991 by Paul Paquet tracking wolves and looking at their response to crossing structures. He found that 50% of the time wolves approached the wildlife underpasses they did not go through. So we designed semi-circular snow transects, 100 m in radius around the underpass ends. We walked these transects every time we checked the crossing structures. We were interested in looking at the behavior of large carnivores that enter the transect area. We classified behavior towards the underpass as either: 1) avoiding it, 2) ignoring it, 3) through-passage, or 4) partial passage (for animals that travel in packs). This winter we walked a total of 343 transects and large carnivores were detected 32 times. For wolves 16 out of 20 times behavior was not modified at the underpass. For cougars, 11 out of 12 times behavior was not modified. This is a very small sample size, the results are preliminary, and we plan on continuing this work next winter and on into the future.

Are the TCH mitigation measures effective in reducing mortality? This question came up in Rob's talk. John (Woods) looked at this question in 1990, two years post-twinning, and found them very effective in reducing ungulate mortality by 94% and 97% (Table 2). There was no analysis done for carnivores, so we looked at the data - didn't find much - but what we did find was that mortality was practically unchanged for black bears and increased twofold for coyotes. Wolves were not present in the study area prior to twinning.

It's been almost 10 years since the Phase I & II mitigation measures have been in place. So we decided to go back and do a reassessment of their effectiveness to reduce highway-related mortality (Table 2). We compared mortality rates from a 5-year pre-twinning period (1980-85) with a 5-year post-twinning period (1990-1995). For ungulates, mortality is still reduced, anywhere from 83-100%. However, for coyotes, mortality rates are almost 8 times higher. For black bears it's two times greater now, and even though there were no wolves present pre-twinning, there have already been two wolves killed on this "mitigated" section of highway. We wondered if this was a pattern that was occurring through out the Trans-Canada corridor, so we compared mortality rates of ungulates and carnivores for these same two periods from the closest untwinned area (Phase III) and found those mortality rates are basically unchanged.

So what might be some of the reasons for the ineffectiveness of these measures in reducing carnivore mortality? The fence is one reason. It was designed to keep ungulates out not carnivores. In many places it doesn't even touch the ground. Last fall we conducted a survey of this fence and found 3-6 coyote size holes underneath the fence per km. Second, there are 37 one-way gates in this section. We found one third of them to have tracks going through them both ways. Some animals are able to bend up the bars and in some places the gate ends aren't touching. Small to medium-sized mammals can get out onto the highway ROW quite easily. Third, there's little money, if any, budgeted to maintain the fence impermeable. It's extremely important that these budgets are in place not only during the few years post-twinning but annually. As long as there are ways for animals to get under, over or through the fence, we'll never get an idea as to how effective these fences and crossing structures are.

What might we do to improve this situation currently and in the future? Experimentation with design and good old fashioned manual labor. On the Phase IIIA section the fence is going to be buried 1-metre below the ground. There's going to be fewer one-way gates on this section of highway and there's apparently a new design for one-way gates. Lastly, on the Phase I and II section we can't do anything else but go out there and plug up holes ourselves. We'll be doing that this spring.

Lastly, I want to talk about some work we're doing on the 5 Mile bridge underpass. This is the underpass that the grizzly bear uses occasionally. Here we plan on increasing the connectivity of the habitat here. Forest comes up to the underpass but there's about 150 m of open terrain without cover. We plan on widening the travel area just to the left of the support structures by building a retaining wall. We'll put some large boulders up to prevent the Bow River from washing out this area. Finally we'll be revegetating this area with shrubs and trees to connect the forested habitat under the bridge.

Question and Answer:

Q: Do you have any idea why they use the bridge area instead of the underpass?
A: It's higher, it's wider. The disturbance from the highway is reduced because it's further away. In the underpasses the traffic is much closer to where the animals are passing. There's noise effects, light effects from traffic also.

Q: Do you have an idea about the sound levels?
A: Yes, that's something I'm going to be analyzing in a logistic regression to determine what physical and environmental attributes such as distance to forest, type of habitat, openness of the underpass, sound levels, are important in determining the success of these underpasses

Q: We always seem to be providing for animals with something that is depressed or elevated. What about depressing the highway and maintaining the natural gradient? Do you think that would help?
A: Yes, I think that would help. I think even better would be raising the highway and maintaining the natural corridor. Instead of modifying the animal's path of travel, modify our path of travel (automobiles). That's something I'd like to find out from transportation engineers. What are the costs of these raised highways? Everybody I've talked to seems to think it's very expensive and it's difficult to maintain. As you drive out on any highway you see overpasses for cars. It's basically the same thing. I don't understand how there's such a great difference, that it would be more expensive than a 2-3 million dollar wildlife overpass.

Q: For those stats that show ungulate mortality decline, were they corrected for density changes?
A: No, they weren't.

Q: Is anyone monitoring the overpasses now?
A: They will be finished this fall and we will be monitoring them afterwards. We monitored them this winter because they could be used, but we only found one pine marten using them. A coyote went half way through.

Q: Have other overpasses been used by carnivores?
A: Not by carnivores. I know in the western part of the U.S. they've been used by ungulates. In Europe they've been used by ungulates quite frequently. There's only one place I know of that carnivores use them and that's in Slovenia. They're not designed for wildlife however. They're designed for getting shepherds across the highway. Brown bears occasionally use them; however, brown bears in Europe are different in behavior from brown bears in North America.

Q: What will the ultimate appearance of these overpasses look like as far as landscaping or planting trees?
A: They're going to be 70% forest cover and 30% open. Forest cover will include 1.5-2m. high shrubs. About 12 ft high trees will be planted. It's going to take a long time for these to mature and reach their full development. As a crossing structure, it's probably not going to be very effective the first year or even the first five years. It's going to be 10, 15, or 20 years before we start making valid assessments of their effectiveness. I think many people see the first years as being critical where if nothing crosses it's going to be concluded that they are a complete failure. We have to remember it's going to take a long time for animals to get accustomed to these new structures where they live. There will have to be behavioral changes that take place as well.

Q: What's the width of the overpasses?
A: They're 50 m. wide. When you actually get up there it seems like 100m.

Q: Have you looked at the mitigating structures on Phase I and II of the Coquihalla Highway and compared them to the ones in Banff?
A: No, I just got the report, but I haven't looked at it yet.
--I think there's an overpass on Phase III and I think it was used even before it was finished.

Table 1. Through-passage (TP) rate and frequency of use (FU) of ungulates and carnivores at wildlife crossing structures in Banff National Park, 1995-1996.

	%TP	FU
Ungulates		
Elk	93	4,020
Deer	91	1,017
Moose	50	2
Sheep	96	225
Carnivores		
Coyote	94	717
Wolf	96	147
Cougar	96	35
Lynx	70	10
Black bear	82	17
Grizzly bear	100	1

Table 2. Effectiveness of highway mitigation measures in reducing highway-related mortality of wildlife in Banff National Park, 2-4 years and 8-10 years post-twinning.

	2-4 years +/- %change[a]		**8-10 years** +/- %change
	Phase I	Phase II	1980-85 vs. 1990-95
Ungulates			
Elk	-93	-97	-83
Mule deer	-97	-88	-85
W-tail deer	-97	-97	-85
Moose	n.a.	-100	-100
Sheep	n.a.	-100	-93
All spp.	**-94**	**-97**	
Carnivores			
Coyote	+180	+210	+770
Black bear[b]	0	-100	+200
Wolf[c]			2 kills

[a]Woods 1996. [b]N=1. [c]Wolves not present in study area.

A multi-level approach to investigating movements of large mammals in the Lower Kicking Horse Valley, British Columbia

Mike Demarchi

LGL Limited
9768 Second Street
Sidney, B.C., V8L 3Y8
E-mail: demarchi@lgl.com

Keywords: British Columbia, highway planning, tracking, Trans-Canada Highway, transect, wildlife distribution, wildlife movement corridors, species diversity

Abstract

Like the difficulties of accurately estimating population sizes of large mammals in forested habitats, determining where and when those animals move through such environments is formidable. However, an attempt must be made to understand their movements so the negative impacts of developments such as highways can be avoided or mitigated.

Following the provincial government's preliminary proposal to upgrade the Trans-Canada Highway through the Kicking Horse Canyon, we embarked on a project on behalf of the Ministry of Highways to identify the areas that served as movement corridors on both daily and seasonal time scales for the species that used them. Although the Kicking Horse Valley is generally recognized as being of relatively low quality for larger mammals in the East Kootenay (especially during the critical winter period), the study area includes two bovids, four cervids, two ursids, two canids, three felids, and several mustelids.

Our approach to detecting and monitoring wildlife movements was to utilize several techniques simultaneously. For many reasons other than cost, we opted not to embark on a telemetry-based approach. Rather, data sources included aerial surveys (winter and summer), winter track counts (along transects and along the existing highway), summer track counts, the "string" technique, pellet plots, incidental observations (animals and their sign), information from other wildlife researchers working in the area, road- and rail-kill statistics, interpretation of bio-physiography, and interviews with local naturalists.

Although much of our data still requires analysis, there has been an overwhelming agreement between the results of the different methods analyzed thus far. In our opinion, a multi-level approach to investigating wildlife movements lowers the likelihood of a "type II error" and provides references against which the results of other methods can be compared and interpreted. Further, an important benefit of using several approaches to data collection is that each one contributes unique insights into the solution of determining where and when animals move through, or reside in an area. Such insights are crucial to the formulation of effective approaches to avoiding or mitigating the negative effects of highways on wildlife.

Introduction

We conducted a wildlife study in the Lower Kicking Horse Valley from late 1995 to early 1997 on behalf of Ministry of Transportation and Highways (BC MoTH) in response to the proposal to twin the Trans-Canada Highway (TCH) in that area. The particular section we studied was between Golden and the western boundary of Yoho National Park (YNP). Previous work done here by consultants looking at habitat and vegetation showed that more information was needed on what species were of concern with highway development in that area. Our study objectives were to: 1) document the occurrence of large mammal species in the area, 2) look at the distribution and relative abundance of those species, 3) look at areas that are important wildlife habitats, 4) identify areas that are or could be used as movement corridors seasonally, daily as well as genetically over generations, 5) recommend approaches to impact avoidance, mitigation and concerns related to passenger safety, and 6) identify any data gaps and make recommendations for a future monitoring program.

Study area

The study area runs 26km from the western boundary of YNP through the Kicking Horse Valley and into Golden where it connects to Highway 95. The options to twin the TCH are very restricted by the steep terrain of this area. Also, in many areas there's not a lot of terrain that's conductive to wildlife movement. At the western end of the Kicking Horse Valley where it meets the Columbia Valley the area is quite open. Much of the Kicking Horse Valley is quite narrow with steep canyon walls. As you move eastward, the Kicking Horse Valley opens up and where it comes up to the Beaverfoot Valley and turns northward, things get a lot more open and better for wildlife movement there.

Habitats are also quite varied along with the topography. In the east there are some nice aspen stands mixed in with conifers. The south side of the canyon is mostly a north-facing slope that's cold and supports dense stands of conifers.

Methodology

Our approach was to look at movement corridors along the existing alignment and along an alignment that had been identified by a previous consultant as having potential as a twinning option. That area included parts of the northern side of the canyon and parts of the southern side. So we set up transects from right in town all the way to the Park boundary. Access to some of our transects in the winter time was limited. For example, we couldn't work on steep rock faces and in high-hazard avalanche zones. In summer, we were able to get into some of those areas and look at wildlife use.

To establish the transects, we started at one point and took off with a hip chain along a bearing staying near the existing alignment to assess animal use of habitats that were in the vicinity of the highway. Along the proposed alignment, we also set up transects fairly close to the mapped route. A section along the transect was marked every 50m and within those sections we set up segments with green cotton crochet thread. The thread was used to monitor wildlife activity throughout the year, but was primarily used to detect animal movements in the absence of a suitable tracking medium such as snow. By using the string at a time of year for which we also have track data, we were able to look at the number of

animals breaking a segment of string and which animals are breaking the string in a given area.

In the summer time, when we didn't have snow, we dug dirt strips below segments to obtain tracks. A 50m section would have anywhere from 6-10 string segments and we would determine what species, how many, and what direction they were traveling.

Results

From the first year of track data you can see that deer are very abundant. We see some very obvious patterns of the distribution of ungulate species in the study area. For this past winter, similar patterns emerged. Lots of deer and we were picking up some more bighorn sheep in the late fall.

Just an example of how we treated the string data; what we have here is the average percent of string segments broken per day. What we see is a pattern as we go from March 26 to November 14 which roughly corresponded to the snow free period. Looking at the track data, in late spring and summer when animals were molting their winter coats we were picking up a lot of hair on the string. Therefore, in areas where we didn't have track information or pellets, we had information on the type of animal based on the hair caught on the string. Surprisingly, the crochet thread readily picks up hair from moose, elk, deer, sheep, goats, and black bears.

Another approach to our study in a broader context was to look at wildlife distribution as observed during aerial surveys. We conducted three aerial surveys; two in the winter, one in the summer. Here we have a map with all the GPS positioned locations of mountain goats we observed. There was a total of 213 goats sighted on the mountains north and south of the Kicking Horse Valley between Golden and Yoho.

In addition, we didn't just look at large mammals, we recorded wildlife sign wherever we saw it. For example, on the summer aerial survey we recorded golden eagles, hoary marmots and grizzly bear digs. And along our transects when we had sign of an antler rub, bears digging up ants, snowshoe hares, squirrels, or grouse, we recorded them. Even though such things may not have direct implications as far as an elk crossing the highway, they do have implications for the carnivores feeding on them such as marten, cougar or lynx.

Another part of our study was to look at tracks in the snow along the TCH by driving along the highway and identifying tracks beside the highway. We would do this over several surveys. Driving down the highway we recorded a lot of deer in the western part of the study area down around the townsite of Golden. As we go to the east we were seeing elk. There's not a lot of overlap between the two during winter. Bighorn sheep were the other ones that were abundant. Looking at roadkill locations from 1978-1994, I wanted to see if there was a general pattern that matched the general observations we made. Indeed, there was this bimodal distribution with most elk being killed in the eastern portion of the study area and deer being killed throughout.

One of the concerns I have about a study like this is that you go out and take a look at what's happening and you say that's the way it is. But that's not the way I believe it is. Wildlife populations are highly dynamic. Talking with local people I understand the elk population in the

lower Kicking Horse Valley is, in a historical context, quite low. Therefore, we could expect it to be higher in the future. So it's important to consider what could happen under different scenarios. Don't take the snapshot we take as reality for all time.

Elk in the study area were generally up the eastside. These are the two habitat enhancement blocks and we've got aspen and conifer forest down to the river. Then it gets into heavy coniferous forest which is used by elk in the summer time but not in the winter time. Elk in the study area are generally wintering on the south-facing slopes.

Mule deer and white-tailed deer are quite common in the study area at various times of the year. Bighorn sheep were also abundant. Golden represents the northern limit of the Douglas Fir Biogeoclimatic Zone and the northern limit for the wintering range of bighorn sheep. Through no fault of their own, the bighorn sheep are pretty much what I call "welfare wildlife". They're fed supplemental feed in the winter time. In high snow years they probably wouldn't make it unless there were radical changes in habitat capability perhaps through burning or conifer reduction in some areas. The sheep are a common site around Golden in winter and other times of the year. The Golden townsite corresponds to the best wintering range for bighorn sheep, white-tailed deer and mule deer in the study area. Transects in the townsite showed extensive use by these three species. Mule deer are using steep slopes such as this. Most of our sightings of white-tailed deer were up on the bench.

Although they spend most of their time in the high elevation areas, mountain goats frequent three places along the TCH. The first place was down by the Yoho Bridge. We're seeing them during the time of year when the water is flowing such that they wouldn't cross the river. What they're doing is coming down to mineral licks. So there are implications for goats and highways in this area. They're going through the forest a considerable distance to get to those licks which implies that they're probably quite important. The second location is up at the park bridge and there's a third as well that is used as a lick by goats.

Moose were very uncommon in the study area. We picked up a few sightings of moose but for the most part the study area does not support moose nor was it used as a movement corridor by moose.

We attempted to get as much information as possible from locals and other researchers working in the area. For example, Cam McTavish has provided much information on wolves and their movements in the study area. He indicated that they use the eastern half of the study area and do cross the Kicking Horse River.

Conclusions

What we've come up with for the data we've collected so far is that in the east the wildlife movement corridors are not well defined because of the broad openness of the terrain. Here, we've got deer, elk, wolves and bears and they're probably moving back and forth in all directions. I've got the bear in parentheses because we sighted grizzly and black bears but we're not too sure if they're moving across (past research suggests they do). We know elk, deer and wolves are moving across.

The results for wildlife species include two bovids (bighorn sheep and mountain goats), two species of deer (white-tailed deer and mule deer), elk, moose, two species of bear (black bear

and grizzly bear), wolves, coyotes, the three cat species (cougar, bobcat, and lynx), several mustelids, a lagomorph and lots of rodents. There's quite a diversity of wildlife species. We've got a handle on the distribution and abundance of these species and identified the location of prime and critical habitats. We approximated some of the wildlife corridor locations based on distribution, movements and terrain. We came up with some approaches to mitigating impacts and human safety concerns, which will come out of the highway project. We're also now in the process of identifying additional data requirements and monitoring needs as the highway project proceeds.

Question and Answer:

Q: What do rivers cause as far as fragmentation? Are they important in fragmentation?
A: I think at some times of the year they're definitely blocking the movement of animals. At other times of the year when the flow is low or if ice is covering them they're not as much of a factor. In the area of big rivers, it's more of a concern. But I think for the most part, the Kicking Horse River, outside of the high runoff seasons, isn't much of a problem for the ungulates and carnivores in the study area.

Q: If you were to look at the valley now looking the possible sensitive habitats and were able to reroute the highway, where would you put it?
A: I would place the entire highway, based on what I know now, on the south side of the canyon and avoid those high-capability winter range areas of the south-facing slopes. I think the south side would be the area with the fewest overall impacts on wildlife. Probably, there would also be the least number of collisions, improving human safety as well.
--The highway is harder to maintain on that side of the canyon. You decrease the wildlife issue but increase the human issue.
--An increase in avalanche and ice and snow?
--Any area of highway in the shadows has ice build up.

Q: You have highway mortality for animals. Do you have railway mortality for animals?
A: I do have Pat Well's data. I haven't looked at that in any detail at this time. From what I've seen, the railroad through the study area doesn't appear to be experiencing the high levels of mortality that other sections of the Kicking Horse Valley and nearby Columbia Valley are. However, a lot of deer are killed near Golden. That would be your general feeling on it, Pat?
--Pretty close but my data's only since 1993 and there's been a big change, especially in train-killed elk, in the area by the two habitat enhancement blocks. When I was first hired on, in the ensuing five years, there were a lot of train-killed elk there. We do have a lot of deer at the exit to the lower Kicking Horse Canyon. It's a high kill area.

Mitigation developed for harlequin ducks as an outcome of an impact assessment done on the Cheviot Mine

Beth MacCallum

Bighorn Environmental Design Ltd.
110 Seabolt Drive
Hinton, Alberta, T7V 1K2
E-mail: bighorn@ycs.ab.ca

Keywords: banded birds, Cheviot Mine, distribution, harlequin ducks, impact assessment, McLeod River, mitigation, monitoring, road and rail construction

Abstract

In 1996, a joint study was initiated to describe the distribution and abundance of harlequin ducks in the McLeod River system and to develop a program to monitor the impacts of the proposed Cheviot Mine on harlequin ducks. The proposed Cheviot Mine is located in the Foothills of Alberta about 80km south of the town of Hinton. Study members were: Cardinal River Coals Ltd., Alberta Natural Resources Service, Canadian Wildlife Service and Jasper National Park. Cardinal River Coals Ltd. funded the study and Beth MacCallum, Bighorn Environmental Design Ltd. carried out the work.

Sixty-four birds were banded and it was estimated that there were 58 adult birds in the McLeod/Whitehorse River system using mark-resighting data (Chapman, 1951). Eight walking surveys were conducted throughout the summer, and bird distribution was plotted for the spring courting, summer staging, brood rearing and fall migration periods. The breeding status of surveyed streams in the Cheviot area was identified. A chronology of harlequin activity on the McLeod River was developed and used to identify seasonal concentration areas. The annual life cycle of harlequin ducks in the McLeod River system was described.

The chronology of use and the distribution maps of the upper McLeod River were then used to develop a detailed construction schedule for restoration of the rail line and for the building of the road. This schedule will be included in the bids for construction of the road and the rail line should the Cheviot Mine receive approval.

Introduction

I'm going to be talking today on mitigation developed for harlequin ducks as an outcome of an impact assessment done on the Cheviot Mine. This talk focuses on mitigation developed specifically for the road and rail construction phases and does not deal with the mitigation developed for the mine construction phases. I will first describe the harlequin duck, after which I will provide a brief review of the project, discuss the issues that were identified in the application, and then describe the detailed field work and the development of the mitigation for the proposed rail and road phases for this project.

The harlequin duck

The harlequin duck has been identified by most jurisdictions in North America to be a species of special management concern. In Alberta, they're *Yellow(a)* listed and in B.C. they're *Yellow* listed. The Pacific Rim population is comprised of 165,000 birds. About 50,000 of these winter off the coast of B.C. The harlequin duck is a *priority species* in Jasper National Park. The harlequin duck in eastern North America is listed as *endangered* by the Committee on the Status of Endangered Wildlife In Canada (COSEWIC).

The harlequin duck is a long-lived bird characterized by a low rate of population turnover. It's adapted to years of high juvenile mortality followed by years of good success. It lives in fast flowing streams and its range is restricted in North America because of its habitat requirements (see Figure 1 for summer and winter distribution in North America). The harlequin duck is a poorly understood species in terms of its basic biology. The definitive work on this species was done in Iceland in the late '60's and early '70's; however recent work done by post graduate students at Simon Fraser University and elsewhere should begin to be published in the peer-reviewed literature.

Study area

Cardinal River Coals Ltd. operates an open pit coal mine located 50km south of Hinton, Alberta. Hinton is about 20 km east of the Jasper Park east gate and is about a three hour drive west of Edmonton. The current mine, known as the Luscar Mine will be running out of coal in about the year 2000. The proposed Cheviot Mine is a replacement mine and is located about 20 km south of the Luscar Mine. The site of the proposed Cheviot Mine occupies the abandoned townsite of Mountain Park which was constructed to mine coal between 1907-1950. This mine and numerous other mining towns in the larger region known as the Coal Branch were closed down in the late 1940's and early 1950's when alternate sources of energy became available.

The site of the proposed mine is drained by the headwaters of the McLeod and the Cardinal Rivers. The McLeod River flows into the Athabasca River which eventually empties into the Arctic Ocean. The Cardinal River flows into the Brazeau River and the North Saskatchewan River which makes its way into Hudson's Bay. The road and rail access to the Cheviot Mine will run parallel to the McLeod River for about 10 km. There is currently a rail line and road in place along the McLeod River valley but the rail line will need to be reconstructed and the road will be upgraded to a 90 km per hour standard.

Project overview

The impact assessment for the proposed Cheviot Mine was conducted under the Alberta Environmental Protection and Enhancement Act (AEPEA). Wildlife work on the project started in 1991, the same time that the exploration crews began looking for the coal. The bulk of the wildlife inventory was completed in 1993 and 1994 and in November 1994, Cardinal River Coals initiated the public participation process required by AEPEA. The application for the Cheviot Mine was submitted to the government in March 1996 and a joint provincial/federal panel conducted public hearings beginning in January 1997.

In 1994, we realized that harlequin ducks were likely breeding in the area of the proposed mine so we developed a spring and summer inventory for 1995. We spent 7.5 person-days in the spring of 1995 walking the streams draining the proposed Cheviot Mine and 26 person-days walking the same streams in the summer (walking surveys can underestimate numbers by 50%). We estimated 9-14 pairs in the McLeod River system and 5 pairs in the Cardinal River system. These numbers were similar to what Jasper was finding in the Maligne system which is one of their best streams for supporting harlequin ducks in Jasper National Park. We also identified a spring concentration of pairs located on the McLeod River downstream of the mouth of Whitehorse Creek (Figure 2). We concluded that the region supported an important population of harlequin ducks and recommended further inventory to understand some of the unknowns related to the bird distribution, abundance and mining activity. These results were identified in the impact assessment for which the harlequin duck was identified a valuable ecosystem component (VEC).

The Cheviot harlequin duck study

In 1996, Cardinal River Coals Ltd. initiated a joint study with Alberta Wildlife Management, Jasper National Park, and the Canadian Wildlife Service. The purpose of the study was to:

> Describe the distribution and abundance of the harlequin duck in the McLeod River system, Cardinal River system, and portions of the Gregg River system draining the Luscar mine.
> Develop a long term monitoring program that would monitor the impacts of the Cheviot Mine on the harlequin duck populations.

The objectives were to provide an estimate of the population using banded birds, use the first year results to propose mitigative measures for the mine, develop harlequin specific protection plans for each phase of the mine, identify potential reclamation opportunities for Harlequin ducks, and to provide information to augment other Harlequin duck studies currently being carried out in the Strait of Georgia, Jasper and Banff National Park, and Kananaskis Country. Study group meetings were held on May 16 and May 31 and monthly updates were supplied to all participants as well as distribution maps, population estimates, and life history chronology. In 1996 we completed eight walking surveys of the McLeod/Whitehorse system beginning in mid-May and finishing in mid-September. These surveys required 36 person-days in the spring and 29 person-days in the summer to complete. We also spent 46 person-days banding birds in May, June, and August. We estimated that there were 58 ±7 adults present in the McLeod/Whitehorse system or, about 29 pairs. We identified 11 separate broods with a total of 56 young; seven broods were found in Whitehorse Creek and four broods were found in the upper McLeod River (Whitehorse Creek will not be mined or roaded and serves as a control to the upper McLeod River). The survey results were mapped to identify the changing distribution of birds in the system throughout the season.

The annual life cycle of harlequin ducks using the McLeod/Whitehorse system is depicted in Figure 3. Band returns indicate that the birds winter on Quadra Island, Vancouver Island (near Comox), on Hornby Island, and on White Rock's Boundary Bay. Pairs fly inland and spend May and June courting and nesting. The males leave the system at the end of June and return to the coast leaving the female to incubate the eggs for about 28 days. She raises the brood by herself and then returns to the coast in September or early October.

Figure 4 shows the distribution of harlequin ducks on the upper McLeod River showing seasonal concentration areas. We identified five seasons in which the birds were redistributing themselves along the river.

1. Courting and Nesting (May - June). -- This is the period when pairs return from the coast and spend time foraging and mating. During the breeding season in May and June, birds were found on the McLeod River from the mouth of Mackenzie Creek to the upper reaches. Females found on the lower stretches in this season appeared to be flying upstream to lay their eggs, returning to feed on the lower stretches with their mates. For example, the female White NZ was captured on May 28 on the McLeod River upstream of the Watson Creek campground. Despite multiple surveys, she was not observed again until July 30, when she was observed with a brood on the McLeod River upstream of Prospect Creek.

2. Incubation (June 28 to July 25). -- Incubation lasts 27-29 days with an average clutch size of 5.6 eggs. The median start date for incubation was estimated to be June 28, 1996 (range June 13-July 18) by backdating from the median hatch date of July 25 (range July 10 - August 14) and by assuming incubation to be 28 days (Table 2). These dates are similar to those reported for Banff but about two weeks later than those reported for Kananaskis Country. The location of nest sites in the McLeod River system was inferred by the location of single females during incubation, and the location of the young broods in the bright downy stage (1-5 days).

3. Staging of Non Breeding Females (July 19 - July 31). -- Twenty-one separate females were observed in the upper McLeod River during this two-week period (density of 1.8 females/km). Of the 21 females observed on the McLeod River, seven were banded (Red 5F, Red 5T, Red 5S, Green BD, Red 8Z, White NZ and White H7) and three had broods. It was assumed that most of the remaining females were non breeding or unsuccessful breeders that were staging prior to flying to the coast to moult. This was demonstrated by female Red 8Z who was observed with six females on July 31 upstream of the water gauge on the McLeod River. She was next observed at White Rock's Boundary Bay, B.C. on August 10, 1996 by Greg Robertson.

4. Brood Rearing. -- The first broods of the year (downy stage 1 - 5 days old) were observed high up on Whitehorse Creek on July 19, and upstream of the mouth of Prospect Creek on the McLeod River on July 22, 1996. The last brood in downy stage was observed on August 1 on Sphinx Creek. The first brood of 1995 was observed July 20 on Redcap Creek and July 21 on the upper McLeod River. Females were still wary and attentive to the young during the August 13-16 survey. They would often be observed in attention posture striving to locate the downstream observer. By mid-August, females were able to move their broods upstream and downstream and were very mobile in the system.

5. Fall Migration. -- This period overlaps with brood rearing. No brood appeared to be abandoned by a female but groups of birds in female plumage were observed on September 9 and 16. It was presumed that these birds were females, young of the year, or a combination, that were staging for migration. The last brood (Red 8T) observed on Whitehorse Creek was found below the ford on September 16, 1996. They were foraging in the creek. No birds were observed on the McLeod River between the canyon and the staging area on the September 17, 1996 survey.

Rail and road construction considerations for the McLeod River

Detailed data collected over the summer of 1996 was used to develop rail and road construction windows that were sensitive to the presence of Harlequin Ducks on the McLeod River. This was accomplished through several meetings, beginning with P. Clarkson (Jasper National Park) on September 20, 1996 and continuing through the fall of 1996 with engineers from Canadian National (R. Morin), Cardinal River Coals Ltd. (L. LaFleur) and UMA (M. LeBlanc) as well as senior environmental staff from Luscar Ltd (R. Ferster). Timing windows developed for rail and road construction through this process were intended to be included in the construction bids should the mine development proceed.

Timing Windows

Timing windows were defined as (Table 1):

Green	Open for construction - September 15 to April 30.
Yellow	Open for construction with some restrictions. The application of Yellow varied with the location of construction on the river as the birds shifted their distribution during the summer and used different stretches of the river for different purposes.
Red	Closed for construction. The application of Red varied with the location on the river (see Yellow).

Zoning

The river was subdivided into four zones to which different time windows applied (Figure 5):

- the McLeod River downstream of the junction of Whitehorse Creek;
- the McLeod River between the mouth of Whitehorse Creek and the first trestle downstream of Prospect Creek;
- the first trestle downstream of Prospect Creek to the mouth of Harris Creek;
- upstream of the mouth of Harris Creek (rail loop).

Construction Considerations

It was initially thought that considerations would be applied to those areas along the river where ducks seemed to be concentrated. This would have applied well to the spring congregation areas as they likely represent some physical attribute that is constant from year to year. The concept would have worked less well in the brood rearing parts of the river where the hens are constantly moving broods up and down the river. If this were a new line there would be a recommendation to leave a 100m buffer between the river and any construction but because the line already existed, it was recommended that considerations should apply to areas where construction would be occurring in the stream, or on the bank, e.g. rip-rap, retaining structure, culvert placement. Twelve areas of concern were then identified (Table 1 and Figure 5).

Zone A - The first two areas are found in Zone A and are defined by the McLeod River downstream of the mouth of Whitehorse Creek. The ducks use this stretch of the river for foraging in May and June.

1. Road Spring – Road KM 6.60 to 6.90

RED - Construction on the road is closed between May 1 and June 30. This is the time when the birds are courting and nesting. Birds are feeding in the stream and loafing on the shore and on the islands in this area. Islands are important security features for these ducks.

GREEN - Construction is open between July 1 and August 15. It is assumed that there is no nesting in this area.

YELLOW - Broods will use this area sporadically between August 16 and September 14. Construction is open during this time but monitoring will be required. Operations may be temporarily suspended for short periods (a few hours) to allow for passage of broods during this time.

2. Junction of McLeod River and Whitehorse Creek – Road KM 8.05 to 8.10

Same considerations as #1.

Zone B - Areas #3 and #4 are found in Zone B and are used by females and broods. It is less likely that nesting occurs at these locations than higher up the stream. Construction windows are longer here than upstream.

3. Rail KM 43.30 to 43.45

YELLOW - Construction is open May 1 to July 18 but monitoring will be required. Watch for single females consistently observed in one place. This may be an indication of a nest.

RED - No activity from July 19 to July 31 when ducklings are in the downy stage and unsuccessful females are staging to fly to the coast.

YELLOW - Construction is open August 1 to September 14 but monitoring will be required. Operations may be temporarily suspended for short periods (a few hours) to allow for passage of broods during this time.

4. **Channel Restoration Area – Rail KM 43.80 – 44.25**

YELLOW – Construction is open May 1 to July 18 but monitoring will be required. Watch for single females consistently observed in one place. This may be an indication of a nest.

RED - Water should not be released when ducklings are in the downy stage July 19 – July 31.

YELLOW – Construction is open August 1 to September 14 but monitoring will be required. Operations may be temporarily suspended for short periods (a few hours) to allow for passage of broods during this time.

Zone C - This zone includes areas #5 through #11 and they fall within the brood rearing stretch of the McLeod River. Nests can be located anywhere along this stretch and broods which are hatched in the upper McLeod and tributary streams are moved down to this stretch for the month of August. While the last two weeks of July are extremely important because the downy ducklings are on the water and the non-breeding females are staging here before flying to the coast, the female will continue to cue on movement in the water and on the shore for the duration of August while her brood is with her. If she is continually responding to new stimuli (construction) throughout this period her brood will be susceptible to higher levels of predation and perhaps be prevented from feeding in preferred foraging areas.

5. Prospect Creek – Rail KM 44.35 to 44.75 and culverts

YELLOW - Construction is open between May 1 and July 18 but monitoring will be required. Watch for single females consistently observed in one place. This may be an indication of a nest.

RED - No activity from July 19 to August 15. Mouth of Prospect Creek may require ground inspection and detailed plan.

YELLOW - Construction is open August 16 to September 14 but monitoring will be required. Operations may be temporarily suspended for short periods (a few hours) to allow for passage of broods during this time. This will be particularly applicable to the last two weeks of August when most broods are still in the system. Construction will be constantly interrupted during these two weeks. After September 1 it can be expected that some broods will have flight capability, or will have moved to the lower stretches of the McLeod River and the need to interrupt construction will be less.

6. Rail KM 45.4 to 45.6

YELLOW - Construction is open between May 1 and July 18 but monitoring will be required.

RED - No activity from July 19 to August 15. There is no nesting habitat here, but work on the hill is visible from a set of pools below and may disrupt the female with broods as she cues on motion.

YELLOW - Construction is open August 16 to September 14 but monitoring will be required. Operations may be temporarily suspended for short periods (a few hours) to allow for passage of broods during this time. This will be particularly applicable to the last two weeks of August when most broods are still in the system. Construction will be constantly interrupted during these two weeks. After September 1 it can be expected that some broods will have flight capabilities, or have moved to the lower stretches of the McLeod River and the need to interrupt construction will be less.

7. Road and Rail Construction – Rail KM 45.60 to 45.69

YELLOW - Construction is open between May 1 and July 18. Watch for single females consistently observed in one place. This may be an indication of a nest. Work earlier in this time frame is preferable than later.

RED - No activity from July 19 to August 15.

YELLOW - Construction is open August 16 to September 14 but monitoring will be required. Operations may be temporarily suspended for short periods (a few hours) to allow for passage of broods during this time. This will be particularly applicable to the last two weeks of August when most broods are still in the system. Construction will be constantly interrupted during these two weeks. After September 1 it can be expected that some broods will have flight capability, or have moved to the lower stretches of the McLeod River and the need to interrupt construction will be less.

8. Channel Restoration Area – Rail KM 45.85 to 46.10

YELLOW - Construction is open between May 1 and July 18. Watch for single females consistently observed in one place. This may be an indication of a nest.

RED - No activity from July 19 to August 15.

YELLOW - Construction is open August 16 to September 14 but monitoring will be required. Operations may be temporarily suspended for short periods (a few hours) to allow for passage of broods during this time. This will be particularly applicable to the last two weeks of August when most broods are still in the system. Construction will be constantly interrupted during these two weeks. After September 1 it can be expected that some broods will have flight capability, or have moved to the lower stretches of the McLeod River and the need to interrupt construction will be less.

9. Rail KM 46.4

Same considerations as #8

10. Existing Man Made Channel – Rail KM 46.80
Same considerations as #8

11. Rail KM 47.25 to 47.40
Same considerations as #8

Zone D - Nests may be located in this area and broods are found here once they are hatched. Broods are eventually moved downstream. Construction can start mid-August but a survey must be done to ensure that all broods have moved downstream by this time.

12. Railway Loading Loop Area

YELLOW - Construction is open between May 1 and July 18. Watch for single females consistently observed in one place. This may be an indication of a nest.

RED - No activity from July 19 to August 15.

YELLOW - Construction is open August 16 to September 14 but monitoring will be required. Operations may be temporarily suspended for short periods (a few hours) to allow for passage of broods during this time. Most broods will have moved to downstream brood-rearing stretches by mid-August.

The above considerations fall within an established knowledge base. The impact of construction on harlequin ducks will increase should construction move out of these time and space windows.

Slides Shown at The End of the Talk
Here's a slide of banding using mist nets strung across the river. Birds are fitted with individually identified colour bands as well as the USFWS metal bands.

This is a picture of the pair in May and June. The female will be concentrating on feeding while the male follows along. You can see the kind of stream they need; rocky substrate and clear waters. When they fly they're like missiles; very fast and very low to the water. They can fly 60 km/hr and have taken out the nets when more than two hit it.

This picture shows the abandoned rail line adjacent to the McLeod River. The line has to be reconstructed. The original rail line was a tremendous amount of work for the early railroaders; they were constantly realigning it because of water overflow problems. They actually had to create new channels for the river in some places. These are high elevation, low gradient streams which is very specific habitat for the ducks. None of these streams are fed by glaciers.

This is a picture of the crew releasing broods in August. Here we caught 8 young and one hen (the average clutch size is 6.5 eggs). The earliest we've observed a brood in summer is July 19. They have only a short time to mature and fly to the coast for winter.

This is Whitehorse Creek and it will not be touched by mining. It will serve as a control.

Question and Answer

Q: You did a lot of detailed work. Could you go to another area, let's say south of there, and predict good harlequin habitat and differential usage of the stream? Could you do that without doing this detailed work or are habitat evaluation abilities to that level?
A: We're doing the population inventory (as well as spatial and temporal distribution) right now and we want to know everything we possibly can so we'll have some reasonable chance to reduce the impacts on these birds. I think we could grossly predict what streams are going to be suitable for harlequins or not. You could throw out streams with beaver dams on them because they're just too stable, they don't have this characteristic (pool and riffle) at all.

The timing is variable. We're about two weeks behind Kananaskis Country in terms of nesting. You can get a handle on this if you have a couple of good studies going. The habitat studies that fisheries have done in the Cheviot area, indicated that early in the spring, pairs of harlequin ducks were found in streams with Reach 1 characteristics while in late summer, females with broods were found in streams with Reach 3 characteristics. The portion of the McLeod River classified as Reach 3 was described as: the water channel is largely unconfined with numerous bars. It is occasionally braided and unstable in the upper reach but rarely confined in the lower section of the reach. Bedrock outcrops occur occasionally in the lower segment of Reach 3. The average gradient of the reach was 1.16%. The dominant habitat type was riffle (71%) bordered by overhanging vegetation; 14.4% of the reach was substantially altered by boulder gardens and cascade. Cobble (49%) and bedrock (20%) were the most frequent substrate type.

Q: Is this proposed railway electric? What are they looking at hauling, what grade, what tonnage?
A: It'll be diesel. It'll be one train a day and they'll be unit trains. Speed will be very slow because of the grades.

Q: You've described the biology. What have you done to relate the potential impacts of the road and railroad to places like Kananaskis where they have these things? You've come up with work windows but I couldn't see why you put work windows there. Do they avoid construction?
A: There's a justification on the last slide as to why we put the windows where we did. That kind of detail isn't normally done at the permitting stage. It's normally done at the licensing stage after the permit has been issued but we went ahead and developed that because the first thing, if the mine is approved, is the road and rail construction. We wanted to put this information into a form that could be put into the contracts for the bids for the road and railway.

Q: How do you think the construction of the lakes will affect the ducks? I know some of the creeks aren't going to be creeks during construction so that will have an effect on the birds?
A: Yes, I'm sure there will be a reduction in breeding potential for the whole system. Some creeks will be filled in with waste rock. That's why we're going to do telemetry this summer to find out the significance of the upper tributaries. We still don't have an idea where they are nesting other than they are using the upper tributaries.

The lakes are not a replacement for stream habitat. They probably will be able to negotiate the lakes as long as it's a flow through. The McLeod itself will have a pit which will be replaced by a lake but there won't be any change in gradients.

Q: So there's actually not going to be any mitigation out on the streams for harlequin ducks?
A: No, that's not true. There will be studies later on looking at habitat and reclamation. Some of the streams will have a settling pond on it for a number of years. There is potential to reclaim that for harlequin habitat. The mitigation for mining will involve reclamation and trying to minimize the destruction of even small portions of the streams during the mining process.

Q: What strikes me here is there are critical times and places to avoid construction activity. That could be generalized to other species, other issues and other places. In Glacier Park there needs to be some slope stabilization done in an area adjacent to a place used by mountain goats heavily but only in the winter and early spring. The issue is to try to move the construction away from the critical times.
A: To try to get a hold of the construction activities is the first thing we'll have to do for harlequins. It's real critical to get in there now and reduce the impact of this phase.

Q: In a general sense, based on habitat requirements you've found for harlequin ducks, would you say low productivity, high turbid systems are not good habitat for them?
A: Yes. They need water clarity as one of the most important characteristics. As well, they need good distribution of food. There has been a lot of invertebrate work done for the impact assessment which will be reviewed as to its relevance to harlequins.

Q: Have you looked at any areas where railroads are adjacent to harlequin habitat?
A: I've been talking to Cyndi Smith who's working in the Bow Valley. She has observed birds using portions of the Bow River which receives heavy train traffic. There will be one train a day when Cheviot is in operation which is very low use compared to the Bow Valley. Our concern was not so much with the operation of the trains as with the construction phases. These birds are really sensitive to in stream disturbance.

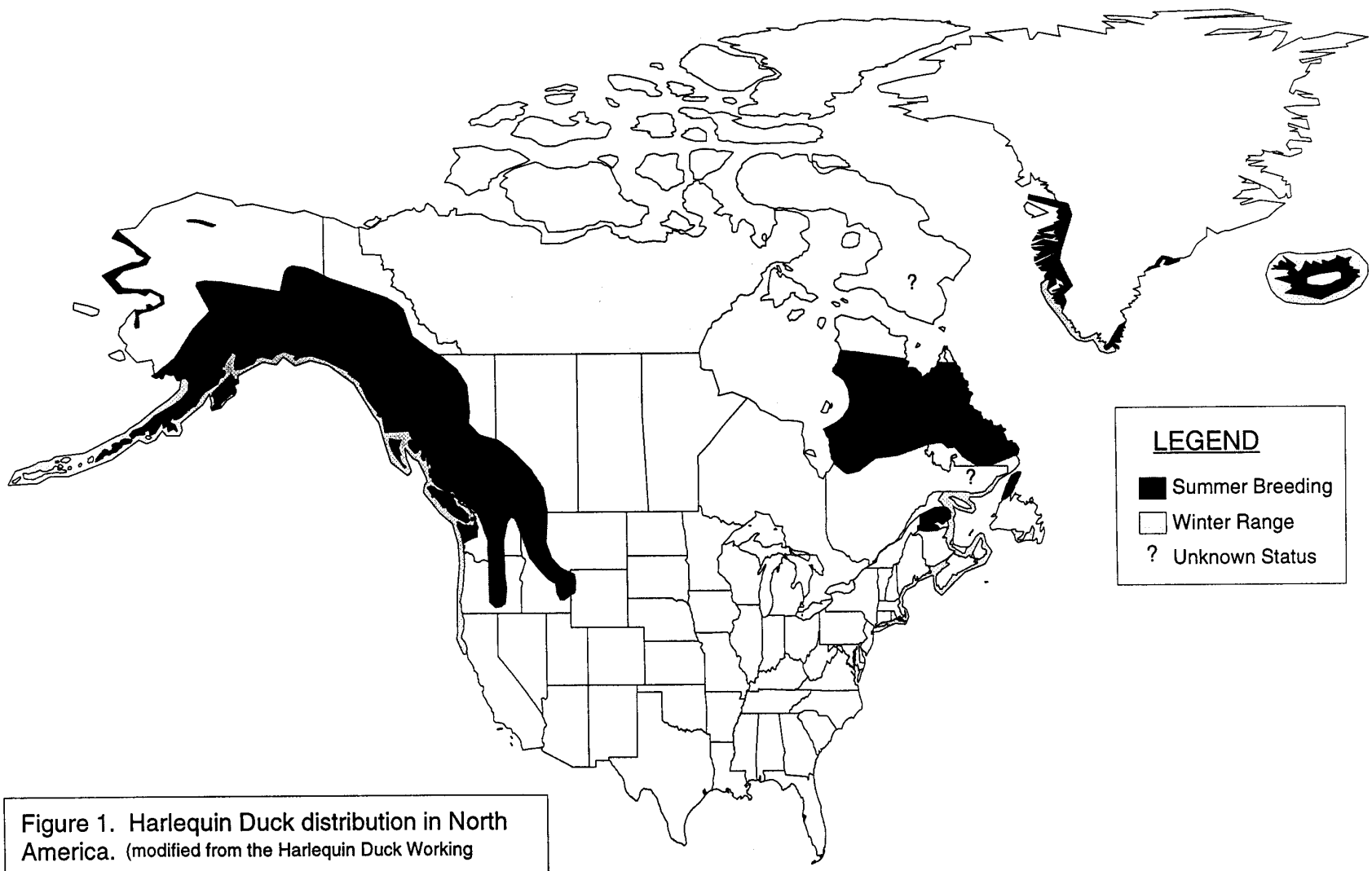
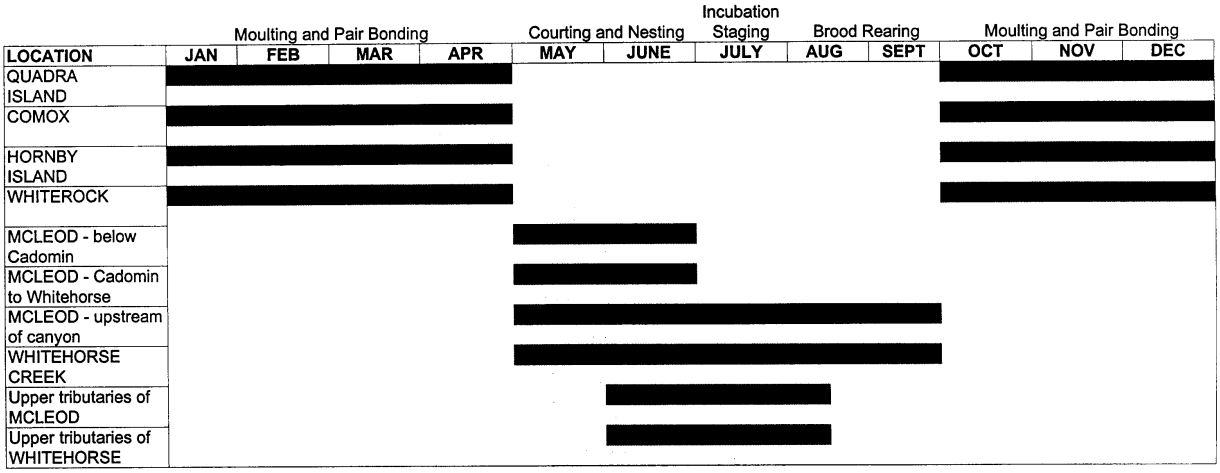


Figure 1. Harlequin Duck distribution in North America. (modified from the Harlequin Duck Working Group 1993; Greenland and Iceland taken from Palmer 1976).

Figure 3. Annual Life Cycle of Harlequin Ducks Breeding in the McLeod/Whitehorse Watershed



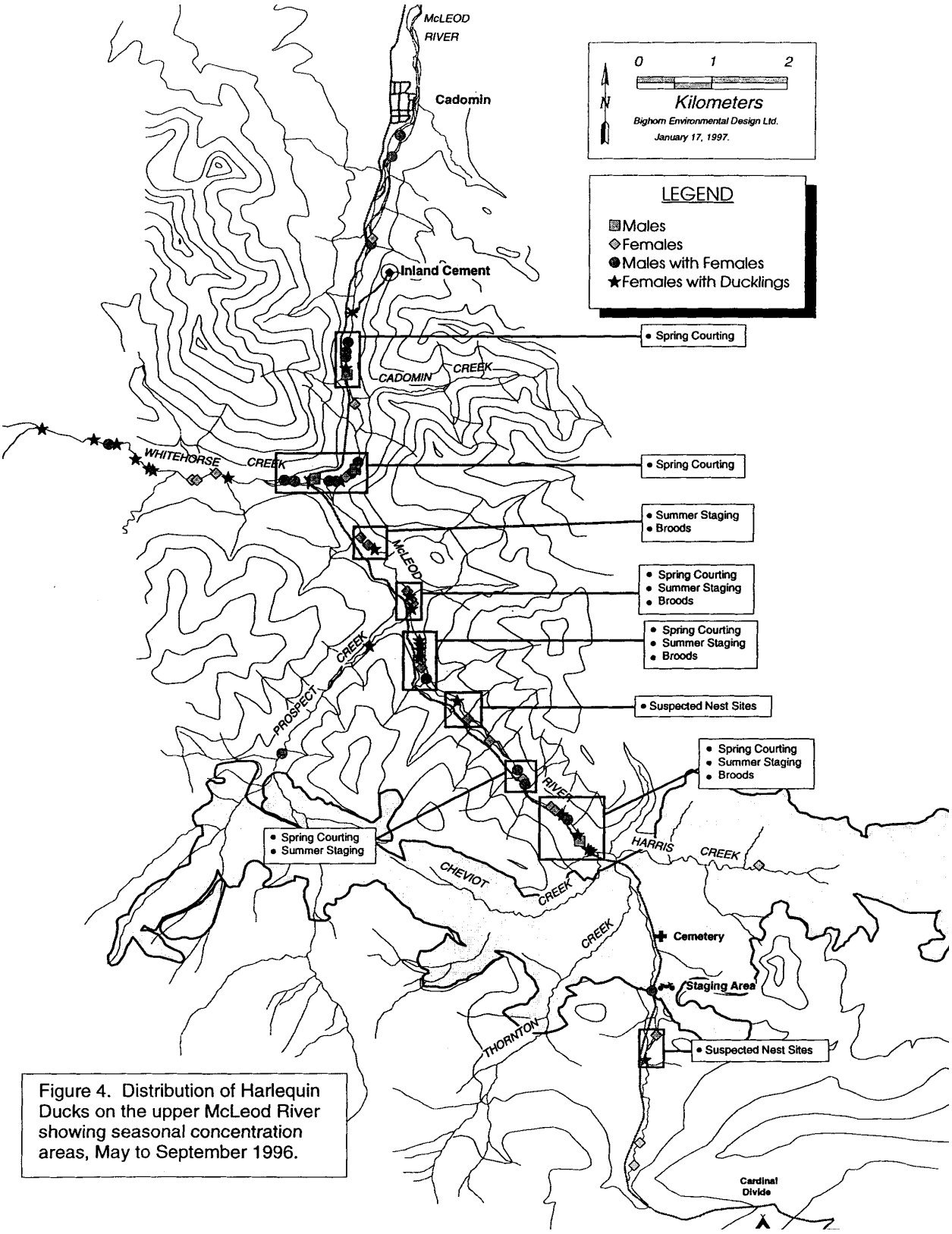


Figure 4. Distribution of Harlequin Ducks on the upper McLeod River showing seasonal concentration areas, May to September 1996.

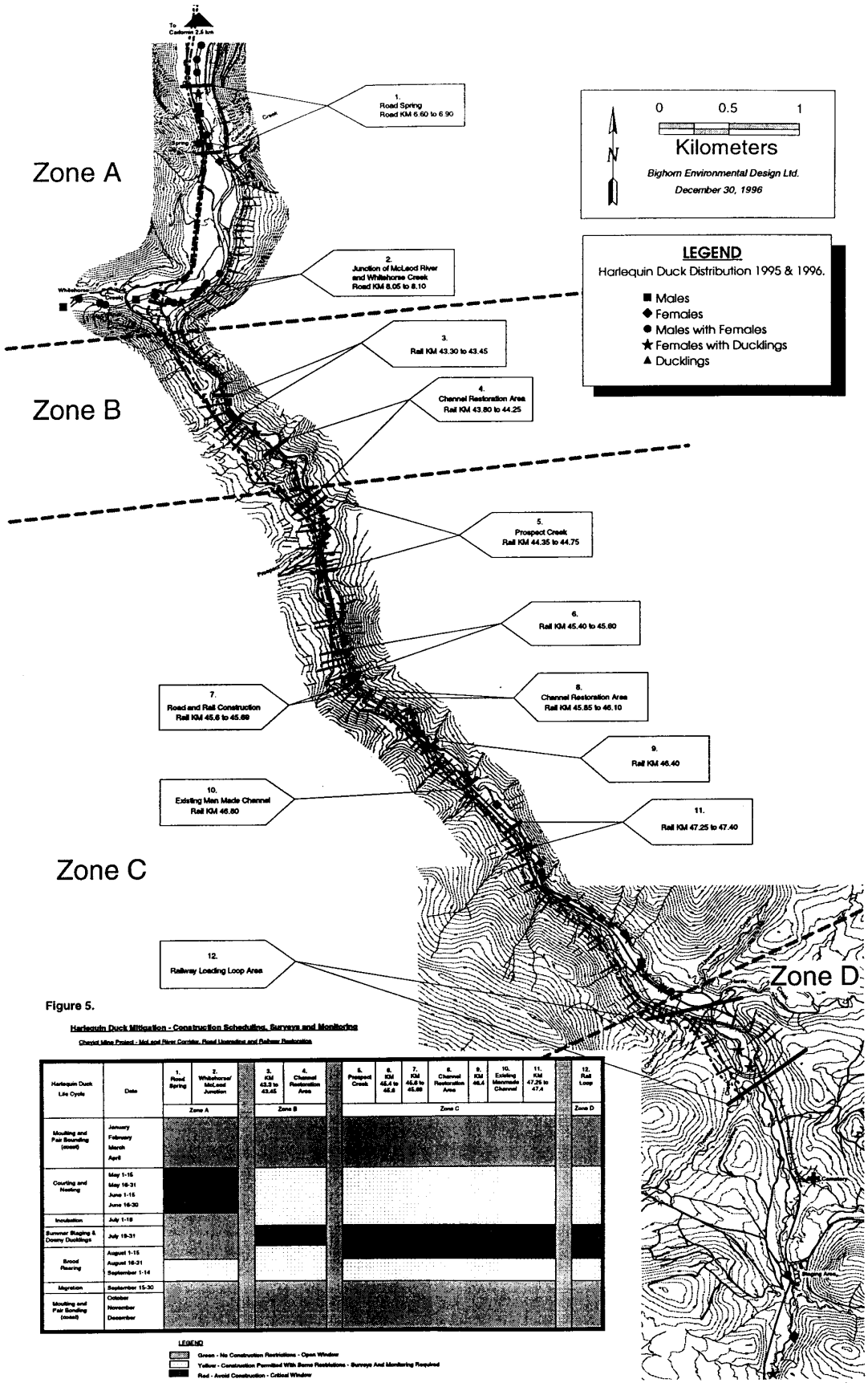


Figure 5.

Harlequin Duck Mitigation - Construction Schedulling, Surveys and Monitoring

Cheviot Mine Project - McLeod River Corridor, Road Upgrading and Railway Restoration

Harlequin Duck Life Cycle	Date	1. Road Spring	2. Whitehorse/ McLeod Junction	3. KM 43.3 to 43.45	4. Channel Restoration Area	5. Prospect Creek	6. KM 45.4 to 45.8	7. KM 45.6 to 45.88	8. Channel Restoration Area	9. KM 46.4	10. Existing Manmade Channel	11. KM 47.25 to 47.4	12. Rail Loop
		Zone A		Zone B		Zone C							Zone D
Moulting and Pair Bounding (coast)	January February March April												
Courting and Nesting	May 1-15 May 16-31 June 1-15 June 16-30												
Incubation	July 1-15												
Summer Staging & Downy Ducklings	July 16-31												
Brood Rearing	August 1-15 August 16-31 September 1-14												
Migration	September 15-30												
Moulting and Pair Bonding (coast)	October November December												

LEGEND

Green - No Construction Restrictions - Open Window

Yellow - Construction Permitted With Some Restrictions - Surveys And Monitoring Required

Red - Avoid Construction - Critical Window

SESSION 2.

Transportation-related wildlife mortality and performance evaluations of measures to reduce it

A regional perspective of wildlife mortality along the Trans-Canada Highway, Kananaskis Country to Salmon Arm

Andrew Whitehead

Wildlife Section
Banff National Park
Box 900
Banff, Alberta, T0L 0C0
E-mail: awhitehead@ucdavis.edu

Keywords: Alberta, Banff National Park, British Columbia, carnivores, fence effect, Kananaskis Country, Trans-Canada Highway, ungulates, wildlife mortality, Yoho National Park

Abstract

Presented are data on wildlife mortality on the Trans-Canada Highway (TCH) from Kananaskis Country, Alberta to Salmon Arm, B.C. Four wildlife mortality databases were used in the analysis: 1) Kananaskis Country (KC; hwy 40 to Banff National Park's (BNP) east gate); 2) BNP; 3) Revelstoke-Glacier National Parks; and 4) B.C. MoTH's Wildlife Accident Reporting System (WARS) from the west boundary of Yoho National Park to Salmon Arm, excluding the National Parks. We analyzed mortality data in all four areas from 1986-94. KC had the highest mortality rate (no. kills/10km). Ungulates accounted for 80-90% of all mortality in BNP, KC and B.C.; carnivores made up around 40% in Revelstoke-Glacier. Summer and fall mortality was highest in all areas. High numbers of black bears were killed during summer in Revelstoke-Glacier. The edge effect of a 27-km long fence in BNP was evaluated. High numbers of wildlife-vehicle collisions occurred within 2 km of the fence edge. It is recommended that in this region a standardized system of data recording be put into place, particularly outside the national parks in B.C. BCMoTH is not currently using a UTM coordinate system for referencing roadkills. It will be necessary that they do so in order to carry out region-wide analyses.

Introduction

Today I'm going to talk about wildlife mortality along the Trans-Canada Highway (TCH) and give you a regional perspective of how it is occurring from Kananaskis Country to Salmon Arm B.C. I work with Tony Clevenger in Banff National Park (BNP) and we monitor the underpasses that were built into the Phase I and II section of the TCH. We also monitor wildlife movement across the TCH on the 2-lane section of the highway. Basically my job entails being out in the field and snowtracking. Unfortunately, all the snow has been disappearing in the Bow Valley this past week so I have been sitting in front of a computer compiling and analyzing these data.

I've had a lot of cooperation in the past week from people who maintain these wildlife mortality databases and I really appreciate their help on such short notice. I have compiled four different databases covering from Kananaskis to Salmon Arm. All were very large showing a lot of wildlife mortality in the past 10 years. It strikes home the reality of how highways are affecting wildlife in this part of Canada.

Study area

The first database we looked at was from Kananaskis. I covered the portion of TCH from the highway 40 interchange to the east gate of BNP. The second database examined was from BNP who maintains their own wildlife mortality database. This database covers from the east gate of BNP to the Yoho NP east boundary.Yoho NP maintains a database, but unfortunately I didn't get their data soon enough to be able to incorporate it in this talk - it will be incorporated into regional analyses we will be performing in the future. The B.C. Ministry of Transport and Highways (BCMoTH) maintains a wildlife mortality database. I used information covering from the Yoho NP west boundary to Salmon Arm, B.C. (not including Revelstoke and Glacier NPs) as my fourth database. I experienced some difficulties using that database; mainly there are a lot of gaps in the data. About 30% of the entries only supplied a date and location but no indication of the species killed. I just looked at some basic seasonal and spatial trends between the databases. There was a lot of variation in the data as the different databases had different methods of recording highway-related mortality data.

Data analysis and results

The first analysis that I looked at was gross numbers of animals killed on different sections of the TCH. All the databases had nine years of data in common from 1986-1994 so that is the data that I queried. We looked at all species. Banff NP leads the pack with the highest number of mortalities over that 9-year period (Fig. 1). However, that doesn't tell you much because the stretch of highway through BNP is about 3 times as long as that through Kananaskis. Therefore, if you look at the number of species killed per 10km of highway, Kananaskis definitely stands out since it is only about a 40-km stretch of highway (Fig. 2). Banff NP comes in second in this analysis, Revelstoke-Glacier third, and B.C. is quite low compared to the others. Again, I think a lot of that reflects the method of data recording and that fact that I was not able to include all the data points from B.C. We also found out that a large majority of the mortalities along that B.C. stretch are only recorded if they cause personal injury or property damage in excess of $1000. There was a curious lack of carnivores smaller than bears such as wolves, cougars, coyotes and lynx. It is difficult to tell whether this is a reflection of the distribution and geographical variation in habitat used by these animals, whether they are just not in the area or whether they are not being recorded in the database.

Next we wanted to see what animals were impacted most. The species were divided into three different guilds; 1) ungulates, 2) large carnivores (bears, wolves, cougars, lynx, wolverines), and 3) coyotes. Looking at ungulates, as expected they dominated mortality counts in all the regions (Fig. 3). Ungulates made up between 80-90% of animals killed in BNP, Kananaskis and B.C. Take note of the fact that ungulates only made up about 60% of the mortalities along the TCH in Revelstoke NP. A large proportion of those numbers were carnivores. Banff NP had a higher proportion of coyote kills than the other Parks. B.C. had recorded very low large carnivore and coyote mortality rates.

Next I divided the data into seasons. Summer and fall total mortality numbers in all the Parks were generally the highest, especially for ungulates, coyotes and large carnivores in the summer (Figs. 4-7). Seventy-five percent of large carnivores were hit in Revelstoke-Glacier

NPs. Of that 75%, 34 were summer kills in Revelstoke-Glacier. Thirty-three of those animals were black bears and the other was a grizzly bear.

Looking at a more local analysis, summer and fall in BNP accounted for 72% of the year's mortalities with ungulates dominating. There were very high numbers of coyotes compared to the other Parks. That might be because they are easily able to get through the fence and the one-way gates. A couple of times this winter I observed coyotes crossing highway and it is amazing how calm and intelligent they are about crossing. Therefore, I am surprised at their high mortality rate. I was driving along the highway a few months ago and a coyote was just sitting in the concrete median that divides the highway. In the middle of the day he had crossed half the highway and was just calmly sitting there watching the traffic waiting for his time to cross.

Carnivore moralities were distributed pretty evenly throughout the year as were the other guilds. This past summer in BNP, five wolves were killed over a 3-month period including three pups and one sub-adult. Those wolves were probably from the Bow Valley Pack and now only one pup survived.

Next, in BNP I wanted to look at the effect of the fence edges. The fence edge construction was completed in September of 1987 from the east gate to the Sunshine Interchange; this is about a 27 km stretch of highway. I looked at mortality numbers from 1988-1995 in areas close to the fence edges. I looked at total mortalities 1-km, 2-km and 3-km on both sides of the fence edge at each end of the stretch. The east gate (easternmost fence edge) showed dramatic fence-edge effects (Fig. 8). The speed limit changes from 90km/hr to 110km/hr at the Park boundary and people begin to accelerate the last kilometer before leaving the Park. I didn't have time to do any rigorous statistics on these data, however, it shows an interesting graphic description of what is going on nonetheless.

In Revelstoke-Glacier NPs, mortality rates were much higher in the summer season, especially in the large carnivore guild (Fig. 5). All of the mortalities were black bears except for one grizzly bear. I don't think that only bear kills were reported due to insufficient data collection because their database was very complete and even included red-bellied snakes, Colombian ground squirrels and a whole lot of animals that you would not expect to find in a wildlife mortality database. In winter, all the bears were denning therefore there were no large carnivores being hit over the period that I queried.

In Kananaskis, the numbers were fairly high compared to the other regions (Fig. 6). Nothing too dramatic happening here. Summer and fall seem to be the highest seasons for mortality along the TCH.

In B.C. things were relatively evenly distributed throughout the year (Fig. 7). Spring was the highest season for mortalities, however, summer and fall were the highest for carnivores. Again the B.C. database was dominated by bears thus no winter kills. The fact that no large carnivores were being hit along the highway in the winter is quite questionable. The B.C. database covered the largest road area of the databases I queried. So you would expect that over a 9-year period there would be at least a few cougars and wolves, but there were none. A lot of the B.C. database is probably property damage related. The B.C. system of recording is quite different from that used by Revelstoke-Glacier NPs; the latter being very detailed. Because of this, it is very difficult and laborious to do a regional analysis of wildlife mortality on the TCH.

For these types of analyses, I think it would be helpful to plot it on GIS and look for mortality hotspots and overlay these data with geographic areas, topography, habitat, traffic speeds, volumes, etc. The B.C. database didn't have mortalities recorded in UTM (Universal Transverse Mercator) coordinates which makes for a lot of effort when doing a GIS analysis.

Conclusions

There are some very general conclusions that you can draw from these data. With regard to mortalities per kilometer, Kananaskis had the highest number of wildlife mortalities on the TCH. Speed and traffic volumes are quite high through this region and it is a popular route for tourists. Banff NP also has high traffic volumes and it is a popular route to Calgary.

Among guilds, ungulates were the highest hit followed by coyotes and then large carnivores. The highest seasons of mortalities were summer and fall.

What can be taken from my presentation is that there are difficulties in this type of analysis. When comparing different databases it is important to keep in mind the sources of information and how data were collected. The theme of the day has been normalizing for population size. What has happened in BNP is that during the 9-year period analyzed, the elk population has shifted from the western part of the Park to the east. That sort of thing has changed. In B.C. are there low carnivore mortalities because there are no carnivores there to be hit or otherwise? These factors need to be to taken into consideration.

It is necessary to work with databases that are equally complete and comprehensive to conduct rigorous analyses of the data that will be able to tell us anything useful in characterizing or describing highway-related mortality of wildlife on the TCH. Lastly, I want to stress the importance of having the data recorded using UTM coordinates.

Question and Answer

Q: Am I to understand that Alberta has a fence from east gate of BNP to Yoho border
A: No, the fence extends 27-km, from the east gate to the Sunshine interchange. Nonetheless, the is quite permeable for wildlife.

Q: What was your source of the B.C. data?
A: Ministry of Transportation and Highways.

Q: Do you know what database? Does it allow for an accurate recording system?
A: Yes, it was the Wildlife Accident Reporting (WAR) system data. The system divided up the highway into regions. To get all the data from Salmon Arm to the Yoho gate, a fellow named Lance in the Victoria office (BCMoTH) had to query it from seven different regions. He had to do about seven different queries, but I'm not sure how it is stored. It is all broken up along that section of highway. Each point location of each mortality is taken from a starting point in that region. With all these point locations you need to figure out which point location is from which starting point and it gets very confusing.

Q: Another variable to keep in mind is the ability of the observer to know what is killed. From personal experience I got a call that a large moose had been killed and what I actually found was a calf caribou. Some system of knowing what they identify would be helpful.
A: That is an important point. In the Revelstoke database they recorded everything perfectly. Deer was divided into white-tailed and mule deer, bears were black bear or grizzly. Other databases didn't do this and this level of detail is important.
--Sounds like some training is needed for the people who collect the data and animals off the road.
--I think a lot of the wardens in the Park pick up the animals and they have more background than the RCMP who are picking up road-kills in say Kananaskis Country or B.C.

Q: I've dealt with the concern of bird kill identification in an aircraft. Rather than trying to teach everybody what each species of bird looks like they have gone to the approach where feather samples are taken and the identification can be done from the feathers. Maybe rather than training everyone they could keep a catalogue of hair samples in a permanent collection.
A: That type of detail and accuracy would be great, but I think it is still fairly informative when you divide species into guilds. When you are looking at a broad perspective it might not be that important to divide things by species.

Q: You had one slide showing different mortality rates along the fence part and the underpass part. Did you do anything regarding the change in ungulate mortality rates versus coyote rates that use the inside of the fence?
A: No
--One point is that coyotes are actually attracted to the high grass in the median.
--The elk like to get inside the fence as well for foraging. You saw that one slide that Tony showed of the bent in one-way gate. We kept going back and it was continually bent in again by elk getting through. So we finally had to nail it shut.

Q: I was interested in your data for the fenced area. The area of fence that has always impressed me is the portion between Merritt and Peachland. Is anyone doing any comparison on that which is the new highway and this very expensive fence and other areas and whether it really makes that much difference?
--I don't know.
--We have found that the fencing system on the TCH in Banff NP has been extremely successful in reducing highway-related mortality, between 94-97% reductions in ungulate mortality after twinning and fencing the highway.

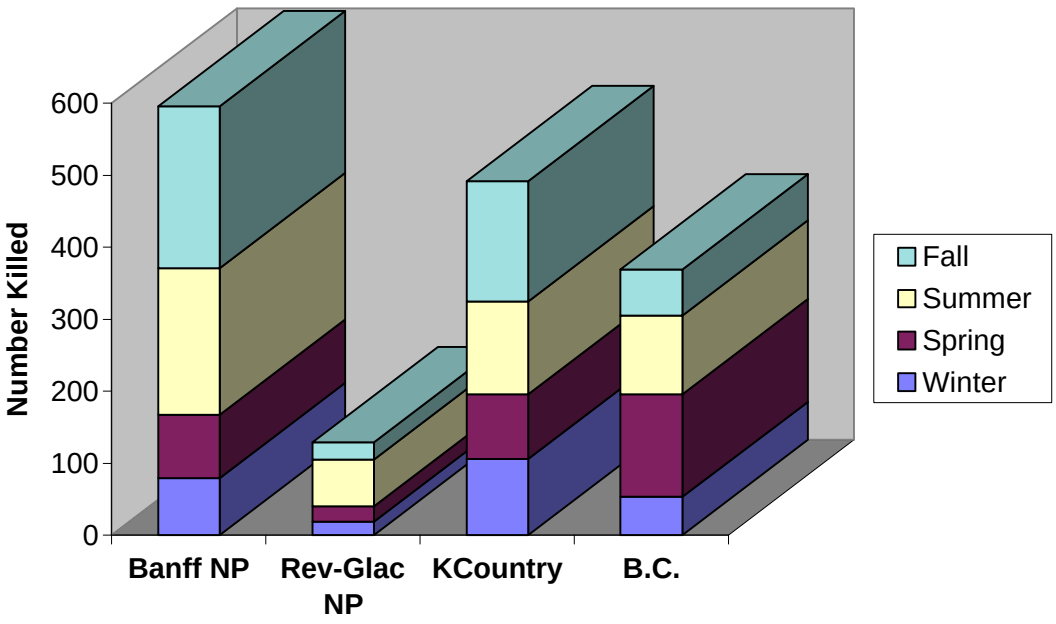


Fig. 1. Number of animals killed by season on the TCH in the four study areas, 1986-94.

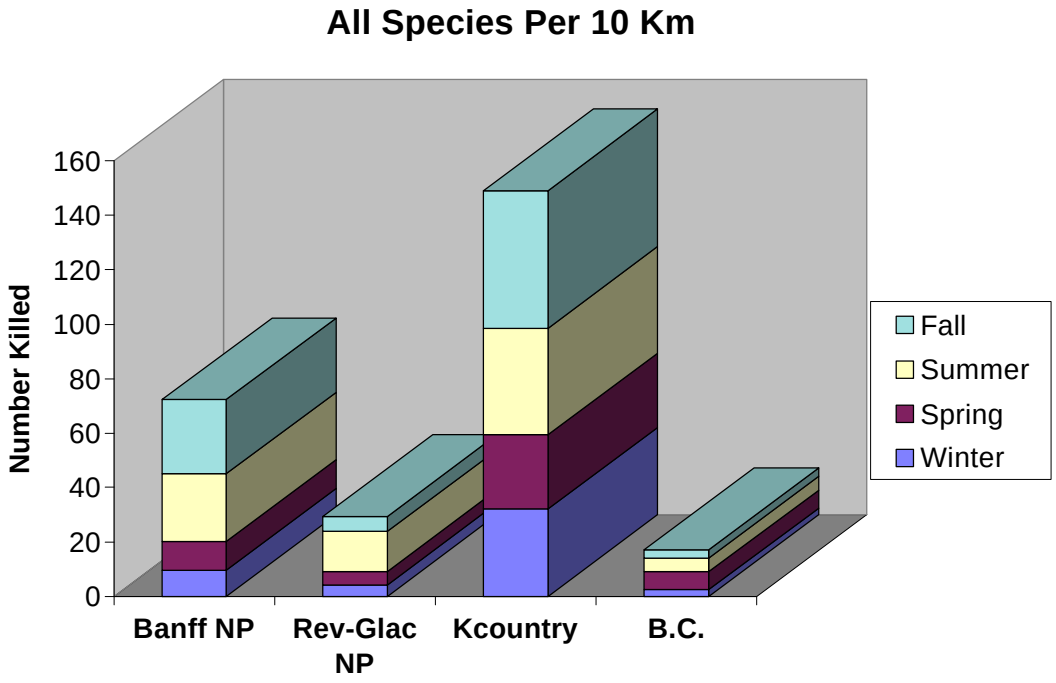


Fig. 2. Total number of animals killed per 10 km by season on the TCH in the four study areas, 1986-94.

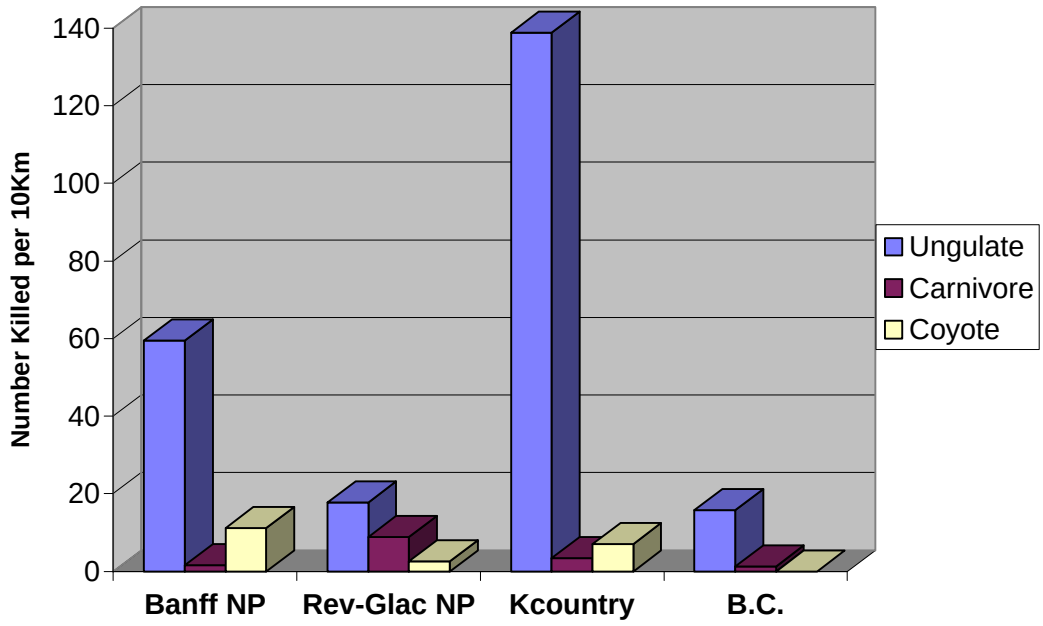


Fig. 3. Number of animals killed/10km of TCH by guild in the four study areas, 1986-94.

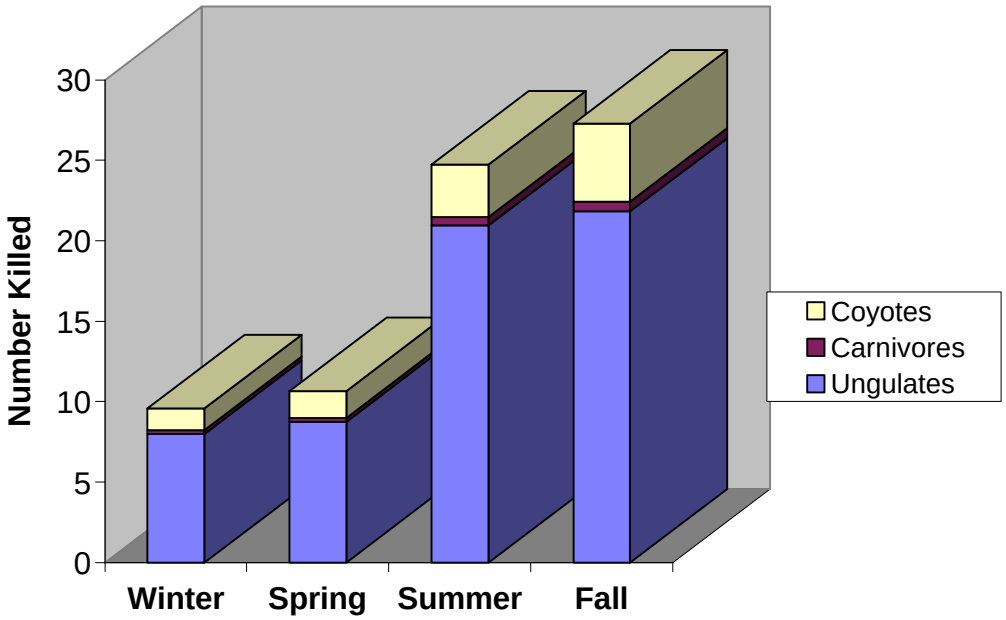


Fig. 4. Seasonal mortality of wildlife on the TCH in Banff National Park, 1986-94.

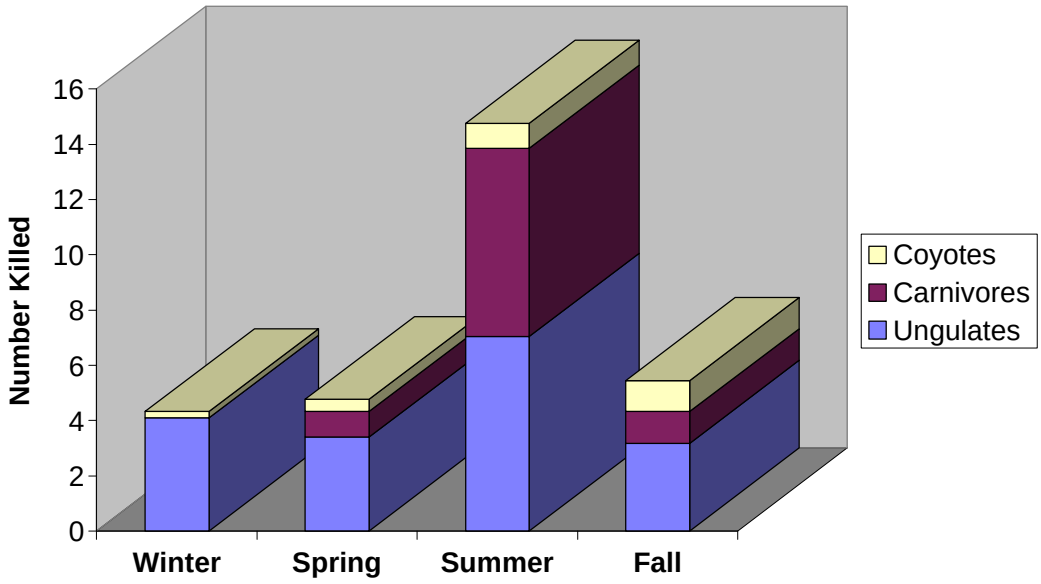


Fig. 5. Seasonal mortality of wildlife on the TCH in Revelstoke-Glacier NPs, 1986-94.

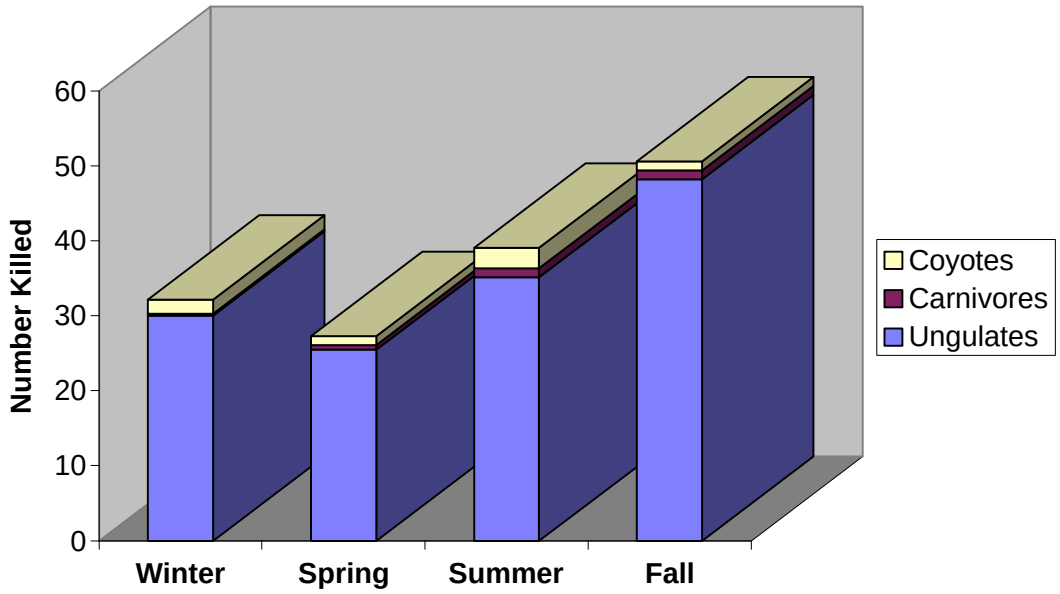


Fig. 6. Seasonal mortality of wildlife on the TCH in Kananaskis Country, 1986-94.

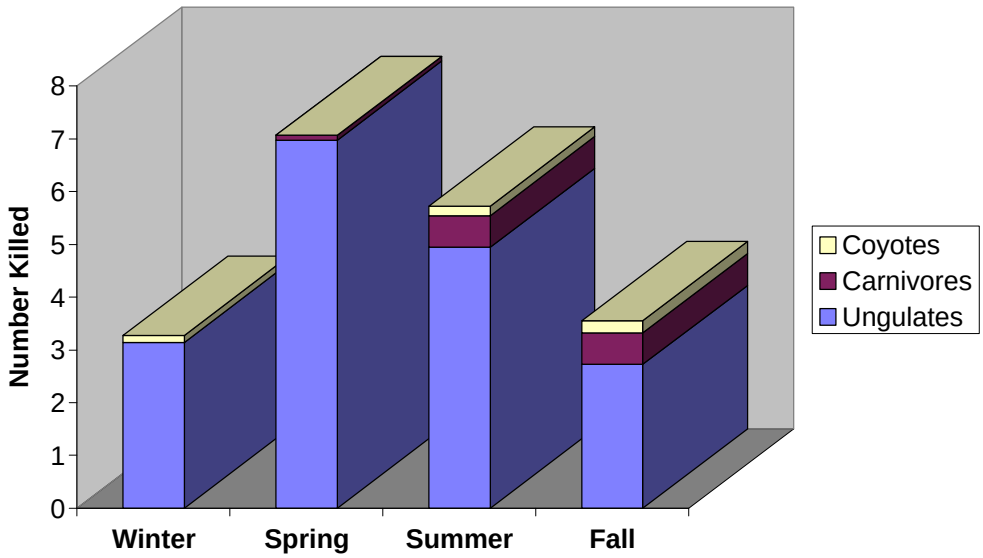


Fig. 7. Seasonal mortality of wildlife on the TCH in British Columbia, 1986-94.

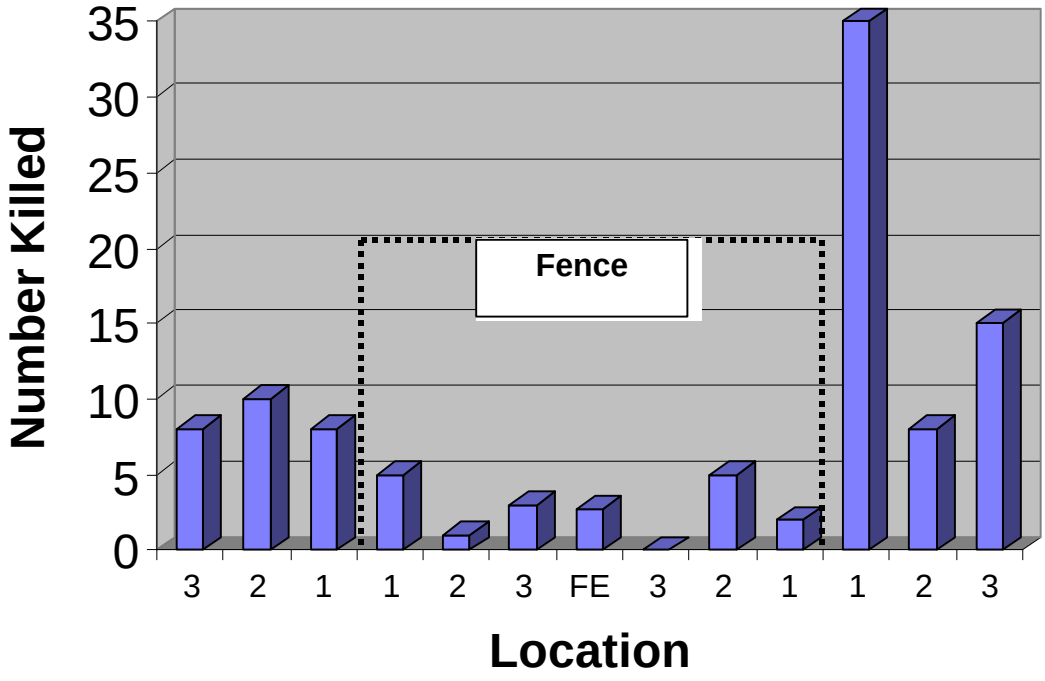


Fig. 8. Number of wildlife killed in and around 27 km fenced section of TCH in Banff National Park, 1988-95.

Licensed British Columbia drivers' attitudes towards wildlife warning signs

Angela Buckingham

Environmental Management Section
British Columbia Ministry of Transport and Highways
4B-940 Blanshard Street
Victoria, B.C. V8W 1E6
E-mail: abucking@vines.gems.gov.bc.ca

Keywords: British Columbia, driver's attitude, mitigation, signage, survey, wildlife-vehicle collisions

Abstract

Collisions between wildlife and vehicles in British Columbia are a serious concern due to human and wildlife injuries and death, as well as the loss of economic resources. Predictions suggest that wildlife mortality numbers will increase in the future. Vehicle-wildlife collisions are not solely a wildlife management problem, but are also a driver management problem. To investigate this matter, the British Columbia Ministry of Transportation and Highways (BC MoTH) conducted a study to evaluate driver response to wildlife warning signs. This study sought to quantify feelings, beliefs and behaviors of B.C. drivers; quantify the effectiveness of current wildlife signage; quantify the effectiveness of alternate wildlife signage and provide data to help direct wildlife-vehicle accident mitigation efforts. The majority (81%) of the survey respondents believe that wildlife warning signs help to reduce wildlife-vehicle accidents. This finding is positive as it indicates a strong public willingness to heed to wildlife warning signs. A small majority (56%) of the respondents believe that BC MoTH should install more wildlife warning signs of the existing sign type. However in regards to existing signage, the respondents indicated a strong preference for a Changeable Message Board (CMB) displaying the "Watch for Wildlife" message over the W-43 (leaping stag sign).
Landscape was also a significant factor in the preferences of the respondents, with heavily forested landscapes having the strongest positive effect and semi-rural landscapes having the weakest positive effect on response for both CMB and W-43.

Introduction

This is an interesting topic and is sort of an offbeat from what our environmental section at the BC MoTH normally does as far as research projects and environmental assessments go. In 1995, a fellow named Peter Eaton who was an employee in our section, brought up this topic wondering about the licensed B.C. drivers' attitudes towards wildlife warning signs. He was taking a course at the university and wanted to apply some of his knowledge and we agreed that it would be an interesting topic to do a study on. I wanted to acknowledge Peter Eaton for all that he has done on this project and this is his data I am presenting today. Peter has since gone on to Calgary where he is completing his master's. I also wanted to acknowledge the British Columbia insurance corporation (ICBC). They did fund some money towards the costs of the questionnaire that was mailed out to households.

Collisions between wildlife and vehicles in B.C. are a serious problem involving personal injuries, injuries to wildlife as well as economic damage. In 1995, over 4,700 kills were reported according to our wildlife mortality reporting system. For every kill that is picked, up there is probably another five animals that have been hit. A lot of researchers have used a ratio from 2.5 all the way up to 15 as far as the actual numbers of kills verses those which are picked up and recorded.

Predictions are that wildlife mortality numbers are going to increase in the future. It is reasonable to assume this given that we continue to increase our road system to give access to more vehicles and more remote areas. As highways are built, there will be more vehicles traveling at higher speeds in wildlife habitats increasing collisions. Wildlife-vehicle collisions are not solely a wildlife management problem, they are also a driver management problem. There has been a great amount of effort to date focused on household techniques of wildlife mitigation and behavior. There certainly is limited data concerned with drivers' responses to warning signs.

In order to evaluate drivers' responses to warning signs the BC MoTH conducted a study. There have been a number of ways discouraging wildlife from the right-of-ways such as fences, reflectors, whistles, repellents or lighting. There are other ways of improving drivers' awareness of the problem. There was a study done in 1980 by Harrison Cooper and Jacobson saying that it is widely recognized that wildlife warning signs, basically the *leaping stag sign* used extensively by the BC MoTH, are generally ineffective in reducing highway wildlife mortality.

In addition to the leaping stag sign, the other sign that the BC MoTH uses is the changeable message board which flashes "Watch for Wildlife". They are the only message boards put up are because there is a concern for road safety and a concern for avalanche falls, etc. The authorities think that "Watch for Wildlife" is an appropriate message to flash up on the board. Sometimes it is done yearround thus not very timely. It should probably be done in the spring and the fall when we do have most of the wildlife-vehicle collisions. It is something that we need to take a closer look at.

The study that we wanted to undertake was to quantify feelings, beliefs and behaviors of B.C. drivers, quantify the effectiveness of current wildlife signage, quantify the effectiveness of alternative wildlife signs and provide direction to minimize wildlife-vehicle accidents.

Survey design

A questionnaire was designed and blank copies are at the back for your appraisal. Basically it was divided into four sections to identify the attitudes and beliefs of respondents. There was also a cover letter that accompanied the questionnaire summarizing the severity of the wildlife-collision problem in B.C.

Section A, the first section, examined the general attitude of respondents to existing wildlife signs. They were also given an opportunity to provide comments on how the BC MoTH could improve the wildlife warning signs.

Section B had eight computer altered photographs depicting the leaping stag sign as well as the changeable message board displaying "Watch for Wildlife". We had these two signs and

we had 3 different backgrounds for them. One was an agricultural farm setting, another was a semi-arid grassland environment and the third was a densely forested environment. We wanted to find out from the respondents how much effect does the sign type or setting have on driver attitude.

Section C had 10 altered photographs depicting both existing signage as well as potential signage options with one consistent background. The objective here was to determine which signage had the greater effect on respondent attitude and also how much does the sign type, the message or a combination of the two have on driver attitude.

The last section obtained some demographic information. We were concerned about the questionnaire quality, so it was drafted up and circulated through the branch and improvements were made. We also had a non-focused BC MoTH group look at it and help improve it. Then we randomly distributed the questionnaire to 5,000 B.C. households in February of 1996. We had a pre-determined closure date at the end of March after which we would not accept any further completed questionnaires.

We were prepared to do a second mail-out dependent upon the response. Out of the 5,000, 1,882 completed questionnaires were returned to our office within that time frame. This is a 38% response rate which is considered an excellent response to a social research questionnaire.

We also wanted to make sure that our survey accuracy level of confidence was high and we were seeking a margin of error $\pm$ 2.5%. This meant that for each item on the questionnaire a minimum of 1,535 responses would have to be given. There were only about four items in the questionnaire that had a margin of error of $\pm$ 5%. They were below the 1,535 responses.

Survey results

I'm not going to go through the full questionnaire, but instead will pick out a few of the questions to give you a pretty good idea of how questions were worded and responded to. This is question #2: "Do you feel that wildlife warning signs help reduce wildlife-vehicle accidents?". We have a response horizontally and the frequency vertically going from strongly agree to somewhat agree to neither to somewhat disagree to strongly disagree. In this case there were 1,860 responses, strongly agree got 463 responses vs. somewhat agree which got 1,040 responses. If you combined positive responses, 80% agreed that wildlife warning signs to help reduce wildlife-vehicle accidents.

Question #3 was a statement reading, "When you see a wildlife warning sign, you watch more closely for wildlife". This was rated from almost never to almost always. There was a positive response, almost always and almost frequently made up 83% of the responses.

Question #4 was a statement reading, "When you see a wildlife warning sign you decrease your driving speed." It turned out that the drivers are more willing to look more closely for wildlife but are not willing to reduce their speed. We got 53% of the drivers saying they are willing to reduce their speed versus the 83% saying they will look more closely for wildlife. That shows a slight change in driver behavior.

Another question read, "Overall do you feel that the changeable message boards are an effective way to raise driver awareness?" The response here was under 1,535 so the margin of error is ± 5%. Fifty-eight percent said they strongly agree while only 2% said they strongly disagree. The vast majority out of the two categories felt that the CRB's are a more effective way of raising driver awareness.

The following question read, "Are wildlife warning messages on changeable message boards less effective than the traditional yellow diamond leaping stag warning signs?" Again for this question the margin of error was in the ± 5% range. This gave generally a negative response of 59%. Throughout the questionnaire there were also opportunities for comments. Comments with regard to the changeable message boards were that because these messages occur on a rotational basis all the time, it was as though it lacked the impact. It didn't seem very personalized. They also felt that it could be interpreted as an opportunity for wildlife viewing. Which is definitely not the message we wanted to get across.

General results

So that is just a sampling of some of the questions we asked and here are some general results of the study. The majority of licensed B.C. drivers believe that wildlife warning signs help reduce wildlife-vehicle accidents. A small majority of respondents feel that the BC MoTH should install more wildlife warning signs, although in the comments it was stated that there was no correlation between where they saw the wildlife vs. where the sign was posted.

A strong preference was shown for changeable message boards displaying the "Watch for Wildlife" message. However, when we asked questions about proposed signage, as Jim Bertwistle was mentioning, by putting for example the number of deer that were killed, the responses of our questionnaire indicated that these two signage options of "wildlife high collision for the next 10 km" or signs that identify the number of kills that there were over a certain section of highway would be more effective. We had 10 different options on message boards that the respondents could put in order as to which would be most effective. It is interesting to note that what we call the W-43 which is the leaping stag sign ranked tenth which is the lowest. The changeable message boards as they are displayed today ranked seventh out of ten.

Recommendations

Some of the recommendations that came out of the survey is that the BC MoTH should conduct some field tests looking more closely at our signage options. It may be more beneficial to use the signage options that ranked higher in the proposed signage portion of the survey.

ICBC through their *Roadsense Project* has been trying to undertake a wildlife accident awareness campaign and part of this project was funded through this program. Another recommendation is to evaluate existing wildlife warning sign locations. The B.C. drivers who were surveyed felt that there was quite a bit of disbelief as to the location and what actually happened. A number of these wildlife signs have been up there for decades and we were hoping that by talking to various managers, we could get a better handle on where these signs should be and ensure advantageous locations.

The report has not been published yet and I am now reviewing the final draft and would like to give it to the printers very shortly. If you are interested in obtaining a copy, please just give me your card. We also have copies in the back of the room of the wildlife accident annual report for 1995. We use this report as well as the WAR system to look at problem areas and see different ways to implement mitigation techniques there. There is a lot more to the questionnaire and analysis in the report than I presented here.

Questions and Answers:

Q: You said you collected demographic data. What were you looking at and were there any statistically significant differences in the categories?
A: When we randomly sent this to 5,000 households, we asked that a B.C. license holder fill this out. We asked information such as how long have you had you license for? What your age is? How many kilometers do you drive? Do you drive commercially? There was some cross correlation analysis but nothing really came out of it. It was noted that the majority drive in urban or semi-urban areas.

Q: Motor vehicle accidents from an insurance perspective, is it not seen as a comprehensive claim?
A: I don't think so, it is different from Alberta.

Q: If it is not seen as a cost to the individual, whether or not the sign is there is immaterial because if they happen to have an accident that does involve an animal, there is no cost and therefore what is the risk? As opposed to having a direct cost to the person.
A: All of the wildlife kills that we do collect are strictly based on our road contractors picking them up and recording location, species, etc.

Q: That does not answer my question. I think for people to be concerned it has to be something that impacts them personally and financially. I think that under the current insurance process, wildlife accidents don't impact on your pocketbook. It is treated as a comprehensive claim. If you wanted to change the process you would have to talk to the insurance people in B.C. and say that it should be costing the driver.
A: We have come up with a number of ideas and various options. Often it is ones that hit the pocketbook that will make a difference.

Q: Was there any discussion given to photoboards?
A: No that was not one of the options.

Q: When I lived in Nova Scotia, they had a problem with pets chasing deer, they put up these 10ft by 8ft posts up with a living doe with her hind quarter chewed away and the question "do you know where your dog was today?" They were very effective.
A: Something similar to this was done at ICBC during part of their Road Sensor. They showed an animal in contact with a vehicle demonstrating an impact situation.

Q: We've been doing a lot of work on manuals and this sort of data. People are so swarmed with this type of data that they don't pay attention anymore. There are so many signs and billboards that it appears that drivers blank them out like the commercials on T.V. If you talk to commercial companies advertising billboards they will tell you the same thing.
A: The drivers indicated that they noticed the wildlife warning signs more so in rural environments than in city streets. It did surprise me the high percentage that said they did notice wildlife warning signs. I would have assumed that numbers would have been lower than that.

Performance evaluation of wildlife reflectors in British Columbia

Chris Barlow

British Columbia Ministry of Transportation and Highways
2726 Prior Street
Victoria, B.C. V8T 3Y1
E-mail: cbarlow@galaxy.gov.bc.ca

Keywords: British Columbia, deer-vehicle collisions, mitigation, performance evaluation, swareflex reflectors,

Abstract

Swareflex wildlife reflectors have been used in British Columbia for many years, yet a proper evaluation has not been conducted testing their effectiveness in reducing deer-vehicle collisions. Furthermore, test results from international literature are often inconclusive or contradictory. The B.C. Ministry of Transport and Highways (BCMoTH) initiated an experiment in the Kootenays evaluating the effectiveness of reflectors in conditions characteristic of B.C. Four test sections were established and reflectors were installed in summer 1995. Experimental design consisted of monitoring study areas for deer-vehicle collisions with reflectors both covered and uncovered. Preliminary results indicated that two of the four highway test sections showed encouraging results, however, the other two areas had low kills, therefore not permitting any conclusions. Reflectors might work better in some terrain and conditions than others. This study was done between October and June, which might need revising. When installing reflectors, location, terrain and geography are very important. Snow was another major factor as reflectors are not effective in winter conditions with a lot of snowfall. Communication is very important for obtaining accurate data. The duration of the experiment was too short and for good sample sizes 3, 4 or 5 years of study are needed.

Introduction

Swareflex wildlife reflectors have been in use in British Columbia for some time, however there has not been a proper evaluation conducted to test their effectiveness in reducing deer-vehicle collisions.

Results from international literature are often inconclusive or contradictory. The B.C. Ministry of Transport and Highways (BCMoTH) initiated a scientific experiment in the Kootenays in order to evaluate the effectiveness of these reflectors in conditions characteristic of B.C. Four test sections (of various lengths) were established and reflectors were installed in summer 1995. Experimental design consisted of monitoring study areas for deer-vehicle collisions with reflectors both covered and uncovered. This presentation will discuss the methodology, implementation, monitoring, preliminary results and lessons learned from the experiment.

In 1995, the Ministry of Transportation and Highways in British Columbia (BCMoTH) initiated a research project examining the use of wildlife reflectors as mitigation measures. The purpose of this study was to test the effectiveness of swareflex wildlife reflectors in reducing the number of deer-vehicle collisions under conditions characteristic of B.C. My talk today will

include an introduction to the study and the methodology involved, implementation and monitoring techniques, provide preliminary results from the project and finally share lessons learned to date from conducting this type of study.

I should clarify that I am talking about the newer model of swareflex reflector, which is also known as the streiter-lite *(sp?)*, and it is different from the older version that some people might be familiar with. The older version of the reflectors consisted of two models used in different terrain, one was used in flatter areas and the other was used in sloping terrain. This model can be used in all topography and is therefore much more convenient and easier to use.

The rationale for the study was that deer-vehicle accidents result in severe economic losses through vehicle damage and also cause personal injury and death. The BCMoTH currently uses several measures to mitigate this problem such as reflectors, wildlife warning signs and exclusion fencing with underpasses and overpasses for wildlife crossing. There remains some uncertainty as to the effectiveness of these various mitigation measures. One of the uncertainties being the effectiveness of wildlife reflectors in preventing deer-vehicle collisions.

The swareflex reflector system consists of a series of reflectors installed on posts alongside the highway. They are designed to catch the light from the headlights of oncoming vehicles and reflect it across the road. In theory this creates an optic fence through which the deer will not cross. The red lens is used because in theory it is supposed to represent a predator's eyes which the deer will avoid.

Previous studies

The reflectors have been tested in the U.S., Canada and Europe, however, completed studies to date do not clearly demonstrate what reflectors do or how they behave under different circumstances. Studies report conflicting results with some of the studies saying that the reflectors work pretty well and others saying that they have no effect on the wildlife.

Examining previous studies was part of my task before starting this experiment. What I noticed was that many of the studies had poor experimental designs. They usually performed a before/after study where they used historical records of how many deer were killed in a certain area before the implementation of wildlife reflectors and compared this to the number killed after reflectors were installed. Those types of studies have been conducted in B.C., but there has never been any concrete scientific tests performed to determine the reflectors' effectiveness in reducing wildlife-vehicle collisions. In addition, the BCMoTH's financial resources are limited meaning that the need to prevent these types of accidents has to be balanced with spending money on other priorities. I wanted to find the best possible way to utilize limited funds to maximize the prevention of deer-vehicle collisions.

In the late 1970's, the province of B.C. started formalizing and rationalizing how they collected data for wildlife accidents. They started what has evolved into The Wildlife Accident Reporting System (WARS). This began to identify hot-spots for wildlife-vehicle collisions in the province.

In 1981, the Fish and Wildlife division of the Ministry of Environment approached the Highway Environment Branch to test reflectors that had been developed in Austria. The first ones were put in down near Christina Lake and they conducted a before/after study. In the first year, they saw quite a large decrease in the amount of kills, but after that the numbers did not seem to be

that consistent. The reflectors were still cost-effective, so the BCMoTH had a policy of installing them in different places every year. In 1995, when I was with the BCMoTH, I proposed that we undertake a better-designed experiment to test their effectiveness in B.C.

Methodology

The design of the experiment consisted of having swareflex reflectors covered for two weeks and then uncovered for two weeks along the highway. The null hypothesis to test was that the number of deer killed at night with the reflectors covered equals to the number of deer killed at night with the reflectors uncovered.

We used the WARS database to determine areas suitable for the experiment. We chose areas with consistently high numbers of deer-vehicle accidents. The next step was to install reflectors on both sides of the road at various lengths and divide those lengths into subsections. An area that was 3 km long was divided into six, each being half a kilometer long. We would cover up the reflectors in half of the subsections (e.g. every other subsection) and leave the other half uncovered, then switch this every two weeks. The sections were monitored twice daily because you had to make sure that you were only recording kills that happened at night. This meant monitoring as close to dawn and dusk as possible. We recorded the date, time of kill, light conditions, location and the status of the reflectors - covered or uncovered. We also wanted to make sure that we were getting a large enough sample size therefore based on previous years mortality data, we determined that two years data should be adequate.

Study area

As far as implementing the experiment, once I had the WARS data and had certain areas of the province circled, I went out and met with local BCMoTH Area Managers, MELP Conservation Officers, local rod and gun clubs and highway maintenance contractors - the people who pick up road-killed animals. The areas that we identified were highway 23 north of Nakusp, highway 6 south of Nakusp, both are along Upper Arrow Lake, as well as highway 33 near Rock Creek and highway 3 near Midway. Those sections were measured out and the posts were installed with reflectors put on.

When installing the posts and reflectors, you have to make sure the distance between reflectors is adequate and this can change with slope and terrain. You usually only use one reflector per post and it faces across the highway, but if you have a steep downgrade that is greater that 11:1 or if you have a ditch that is greater than 4 ft, you would have to put one on the outside of the post as well. I then colored the posts in the various subsections so that when the monitors went by they could refer to the color without carrying a map. I originally used canvas bags to cover the reflectors, but these were quickly stolen. I had to revert to plastic bags taped to the reflectors.

Accurate records needed to be kept primarily of whether the bags were on or off, what species was killed and the date and time. Recording weather conditions was important to see how effective the reflectors were under different conditions. For the monitoring, we decided to go with local rod and gun clubs that were in the area and showed interest. That was actually an integral part of deciding where to put these reflectors, that is, where people would commit to helping me out twice a day every day. I also had to make sure that the maintenance contractors would look extra carefully at these sections and make sure nothing was missed.

Results

Preliminary results to date indicate that the highway 3 and highway 33 sections are showing results, but the areas near highway 6 and highway 23 are getting really low kills, not allowing us to make any conclusions. What this points out more than anything is that these reflectors might be working better in some terrain and conditions than others. In the Rock Creek-Midway area there has been 24 kills up to the end of February (last years data as well as up to February of this year). I have only been looking at the period between October and June because the WARS data indicated that the high kills occurred in the end of fall and beginning of spring, however I might have to revise this.

Right now in Rock Creek area, they are showing 71% kills when covered and 29% kills when uncovered. I should also mention that there has been quite a few kills that I got from maintenance contractors that I couldn't include in this data because I'm not sure when they were killed, whether it was in the day or night.

Conclusions

When putting the reflectors in, location, terrain and geography are very important. On highway 23 you have a steep rock face on one side of the road and a steep downslope on the other side and I don't think that reflectors are particularly well suited to this type of terrain. The snow was another major factor, reflectors are not effective in winter conditions with a lot of snowfall. Some areas up north are actually taking them down in the winter and putting them up in the summer which makes a lot of sense.

As far as the experiment and obtaining accurate information, communication is very important. We need to maintain ongoing consultations with the area managers and local monitors. The duration of the experiment has turned out to be too short as well. Looking at other studies, the ones with good sample sizes occurred over 3, 4 or 5 years. We also need adequate resources in both manpower and financial means to deal with situations that come up such as replacing bags and reflectors.

Questions and Answers:

Q: I was wondering whether they had to be cleaned regularly?
A: Yes, especially in the winter when they get coated with salt, etc. they need to be wiped clean. The monitors for this study were supposed to clean the reflectors when they changed the bags (every two weeks).

Q: You may find that if there is a statistically significant effect of the reflectors that it may or may not match up with a reduction in kills that corresponds to a cost/benefit analysis. Have you got a handle on any sort of a rate of kills that would have to be achieved in order to pay for these things?
A: No, but I would like to look at recent data on how much the average collision with a deer costs and compare that with how much it costs to put up a km of reflectors.

-- p values and the t tables are things that may not mean a lot to a manager. Then you could manipulate your effect size for what you want to detect that is actually beneficial to cost. Then you may have to reduce your sample to size to detect a larger effect size.

Q: What does the individual reflector cost?
A: Around $20.

Q: Do you have any idea on what time of night these deer are being killed? Is it a dusk, dawn or middle of night problem?
A: I don't know in Nakusp.
--There is no traffic on that road at night

Q: It sounds to me like you were suspicious that animals would habituate to them eventually but initially when they were set up in previous studies it looked like there was an effect on the number killed. For the period of time that you conducted your study, you recorded a similar novel effect. Would you say that your results agree with previous studies in that at least there is a novel effect and that we don't know much about habituation at this point. Are you going to extend this study to cover this?
A: That's a consideration. The only problem is that we would have to make sure that the reflectors continued to be covered and uncovered to account for any variables.

Performance evaluation of mitigation measures in Jasper National Park, Alberta

Jim Bertwistle

Parks Canada, Jasper National Park
Box 10
Jasper, Alberta T0E 1E0
E-mail: jim_bertwistle@pch.gc.ca

Keywords: communication strategy, compliance, Jasper National Park, mitigation, performance evaluation, wildlife-vehicle collisions, Yellowhead Highway

Abstract

I will discuss strategies used to reduce wildlife-vehicle collisions that incorporate a variety of ecological factors in Jasper National Park (JNP). Our study area is an 85-km stretch of highway along the Yellowhead Highway. Our main emphasis is on minimal disruption of wildlife movement through this area. We have reversed an increasing trend of wildlife-vehicle collisions and have recorded a 28% reversal over 1995.

Introduction

Today I will discuss measures used in JNP to reduce wildlife-vehicle collisions. My talk will include discussing the socio-economic effects of wildlife-vehicle collisions as well as the results of a compliance and communication strategy that we have used in JNP. Compliance means speeding tickets given largely to truckers. In conclusion, I will cover some of the interesting components of wildlife-vehicle collisions.

Study area

We have data on wildlife-vehicle collisions from 1951 to present on the Yellowhead highway and other roads in JNP. The YH is a major transportation corridor through the Rockies. It is in a montane area with some boreal forest as you go further west. It is relatively flat with a large wide-open valley and high ungulate populations adjacent to it. The YH has high traffic volumes, particularly passenger vehicles and large trucks that are not stopping in the Park but rather going right through it.

The other two major roads in the Park are used by people seeking a Park experience. We have much lower numbers of wildlife-vehicle collisions on those roads, although speeds are significantly higher on one of the roads, the Icefields Parkway.

Wildlife mortality data

This is wildlife mortality from 1980-1996. The blue is the Yellowhead highway and the red is the CNR mainline which also goes through the valley. All wildlife-vehicle collisions for trains and cars are plotted on a GIS-based system. We have about 2500 data points that will tell you the location of the road-kill, the species, the sex, the time of day, the month and those things.

We are using that information to design a compliance and communication strategy. We have had a significant drop in wildlife-vehicle collision on the highway with no corresponding drop on the CNR. Traffic volumes are increasing on the highway at about 4% per year and on the railroad at about 6%.

This is wildlife mortality by location on an 85 km stretch of road. It is marked 0 km at the west boundary and 85 km at the east boundary showing the number of animals killed at these locations. The GIS data will give you species killed at these locations.

This is more about the social component showing that a significant number of animals have been killed. Levels are even higher than this in B.C. in recent years, however levels are close to those shown here when you take a 10-year average. In the last year we have reduced our road-kill to 88 animals from a 10-year average of 114. Property damage is a significant component of wildlife-vehicle collisions.

Vehicle damage

We believe that there is a conflict between major transportation corridors and wildlife. This is based on the fact that it kills wildlife, causes property damage and causes human damage. We started off our program with the assumption that there is a conflict between the two. As well, the trend is increasing since 1951 with no major fluctuations in the trend. It costs about 16 million dollars per year just to fix vehicles that are hit by wildlife. In JNP alone, the cost alone is $250,000 and that is based on an average claim of $2,200 which is all collisions that occur in Alberta. In many rural areas the damage is much more significant.

In Alberta, 48% of the collisions that occur on primary highways are striking wildlife and this is increasing all over North America. These are very conservative estimates. We have noted that with the contracting out of highway services, there is a breakdown in communications in other jurisdictions which doesn't apply to the National Park. Whether information on where an animal is hit is given to the proper authorities who care for the welfare of the animal is unknown. I live outside the National Park and where the road maintenance is contracted out you will often see wildlife lying in the ditch for 2 or 3 weeks until they are consumed by scavengers.

Mitigation techniques

There is no available record that really summarizes the success or failure of numerous mitigation techniques. We heard this morning that one excellent mitigation technique is fencing. In JNP, we are trying to look at techniques that incorporate both the social and biological components. We want to reduce wildlife-vehicle collisions without spending tons of money or limiting wildlife movement.

One of our major implementations was the addition of three *slow-down for wildlife zones* in 1981. Two of these locations were specifically put in for bighorn sheep. However speed did not show to be a significant factor in bighorn sheep mortality, nor is it a significant component of black bear mortality.

In the reduced 70 km/hr zone, we have had some encouraging elk data. The measures taken were focused on large truck traffic that are most responsible for wildlife-vehicle collisions. We

stepped up enforcement of speed regulations in 70 km/hr zones and put CB radios in our warden vehicles and talked to truckers who would communicate to other truckers where the speed traps are causing a lot of slowdown. Enforcement has been so effective on large trucks that JNP is now talked about as a place not to speed.

One of the assumptions made about wildlife-vehicle collisions is that the deer jumps out in front of the headlights and gets hit and that it is an act of God and really had nothing to do with the driver. However, this is not the case and other factors are contributing. In Alberta, if you hit a domestic animal or livestock it is assessed differently than if you hit a wild animal. One is a collision and the other is comprehensive assuming that the collision is the deer's fault. That is just the way that I think most of society views wildlife-vehicle collisions.

We have tried calcium-chloride as a de-icing agent because there is a significant amount of variables that go into wildlife-vehicle collisions. Although the calcium-chloride did not attract wildlife to the road, it did not adequately remove ice build-up and in some cases increased the amount of salt that was applied to the road at a later date.

We tried mineral bait for keeping bighorn sheep away from the road. This was unsuccessful because the dominant male would get in the salt trough and not let any others lick, so the others would wander down to the highway and lick there.

Compliance with communication strategy

The following information is what we are using to design our compliance with communication strategy realm. This is wildlife mortality per month, highway vs. railroad, with the blue being the highway and the red being the railroad. There are some significant differences in mortality. Major traffic volumes are in June, July and August on the highway, but rail traffic is relatively consistent throughout the year. Large truck traffic is also relatively consistent throughout the year but passenger traffic fluctuates widely.

Here is ungulate mortality, with the blue line being highway and the red being railroad. The highway exceeds the railroad in just about all cases of wildlife-vehicle collisions. White-tailed deer just appeared in our stats in the early 1970's. They weren't available in the Park before that and very few are killed on the railroad as compared to the highway. Only grizzly bears are killed more frequently on the railway than highway, but recently we have not had any grizzly bears run-over and this is probably because they are not there anymore.

We also looked at our land-fill which is located adjacent to both our highway and railroad. If you look at our GIS map on grizzly bears you will see that all kills occur adjacent to the land-fill. But we have removed the land-fill now.

This is the type of vehicle involved in a wildlife-vehicle collision and the unknown component is something that needs further research. We don't know a significant component of our collision stats. The yellow is semi-trailer trucks, that is trucks traveling through the Park carrying large, heavy loads. We have significantly reduced the number of trucks passing through JNP in the last little while.

Species mortality trends

Here we have white-tailed deer mortality by month. The reason we have some of these things is to share this information with other jurisdictions as white-tailed deer occur frequently in Alberta wildlife-vehicle collision stats. You can see that there are some significant trends in the time of year that white-tailed deer are killed. There are more kills during June and July in high traffic peaks and during the mating season. It brings in both the human and the wildlife components of wildlife-vehicle collisions.

This is bighorn sheep mortality by month for 1951-1996 and this is much more consistent with the exception of the mating season again. On the left is the sample size of 602 samples.

Mule deer show somewhat different trends than white-tailed deer. We have specific areas where white-tailed deer are killed, specific areas where mule deer are killed, specific areas where bighorn sheep are killed, specific areas where moose are killed as well as some other carnivore species although I've focused this presentation on ungulates. Elk mortality is pretty much spread out along the highway.

This is moose mortality by month. The October, November, December season also corresponds with the onset of salting the highways, or applying winter mix to the highways as well as the mating season. Elk mortality is somewhat more consistent and that is with a large sample size of close to 900 entries for that period.

The point of all this data is that wildlife-vehicle collisions do not occur equally to all species. There are significant differences in how it affects some species. This was the first year that we have had wolves denning in the Athabasca Valley. Wolves are quite common in JNP, but their denning sites weren't recorded in the Athabasca Valley until this year and there were 2 litters - 4 pups and 3 pups. All pups were killed on the highway. No pups made it through the summer. Thus it even affects certain age groups of some populations more than others.

Social components of wildlife-vehicle collisions

We want to look at the social component of wildlife-vehicle collisions. Here I'm comparing two 70 km/hr zones on large truck speed and this is recording only trucks going over 70 km/hr of which there are only a few. The increase in speed in one area is different from the other and we want to get at why that is. Is it due to sign placement? different gradients? or other components? We believe that speed is a significant contributor to wildlife-vehicle collisions.

This is a similar comparison only it is on speed of cars and contains close to a million entries. As the speeds get higher in the 45 km/hr over the speed limit range, cars overtake large trucks in terms of exceeding the speed limit. Twelve percent of the vehicles exceed the speed limit by 45 km/hr and that is out of about a million data points. People are going through there at a pretty high rate of speed.

In the 90 km/hr zone where you are not asking people to slow down, the speed differences aren't as significant. But large trucks are still exceeding the speed limit just over 10-15 km/hr. Cars at 35 km/hr over go faster than trucks.

This is a 70 km/hr zone where once again in some areas trucks are speeding and in other areas they are not. In another 70 km/hr zone where we were looking at percentage of vehicles

speeding, you can see that there are significant differences in areas and type of vehicle in these areas.

We want to survey the passenger vehicle driver and find out what the slow down for wildlife signs mean to them. Many of the people using this road are not stopping in the Park but are traveling right through. I think there is a difference between people stopping and not stopping in the Park. People stopping are looking for wildlife and one of their major activities is viewing wildlife adjacent to the road. The majority of people driving on this road are worried about how fast they can get to Vancouver from Edmonton.

Slow down for wildlife zones

In 1991, we established *slow down for wildlife zones* for bighorn sheep specifically as these are typically not zones where ungulates are killed. The bighorn sheep kill is extremely isolated. They are coming down from a rockface and then onto the highway. Another thing to notice is that bighorn sheep mortality does not occur at night with the exception of some rams in November when they are mating. Bighorn sheep are in their nighttime area and are not on the highway at night. Other ungulates are killed generally at night.

This is total elk mortality along the Yellowhead highway from 1987-1996. You can see that the trends are somewhat increasing or stable. The blue is the whole highway and the yellow is one 70 km slow down for wildlife zone established in 1991. Since this, you can see the overall trend for elk mortality has been increasing, but in the slow down for wildlife zone it has been decreasing. So we believe that the slow down for wildlife zones may be more effective for some species than others. We are not noticing a significant change for bighorn sheep but we do notice some differences in elk mortality. Keeping in mind that two of those locations were put in for bighorn sheep specifically and they are trying to control speed. Bighorn sheep kills are fairly inconsistent and without a large sample size.

Wildlife mortality by hour

This is wildlife mortality by hour as we want to know when to focus our compliance and communication strategy. Do we need lights on our flashing signs or not? There are about 2500 data points over a 45-year period and we have a significant increase at around 7 or 8 o'clock. That is probably when the duty warden comes on shift and writes the time of day on his/her occurrence form. So we want to improve our reporting procedures for when animals are killed. A lot of times whoever takes the report will write down the time they received it verses the time the animal was killed.

We also have this information plotted for each species so you can look at any trends in species kills by time. We are focusing on ungulates because they make up the largest proportion of our wildlife-vehicle collision stats.

Conclusion

So what does it take to reduce wildlife-vehicle collisions with the exception of building a fence? We want to develop strategies to complement the use of transportation corridors through wilderness areas that do not compromise either component, social or biological, that use these areas. That means let's not compromise wildlife movements and let's not get grid-lock where the traffic isn't allowed to move. We have a responsibility to move traffic through a

national transportation corridor. However, can we do it economically and can we do it by modifying driver behavior or modifying wildlife behavior without totally changing it?

It will be very difficult to assess mitigation techniques without current historic trends on wildlife populations adjacent to the highway and traffic demographics especially type, speed, volume, etc. Remember I'm speaking about mitigation that doesn't involve fencing. Those are some of the things that we would like to continue working on. We want to focus on modifying wildlife behavior to a certain extent using the reflectors. The reflectors have shown some success and some failure, largely the results are inconclusive. As I quoted earlier on the study of an American analysis of wildlife-vehicle collision mitigation on deer, the significant problem identified is that there is not enough long-term data to accurately assess most mitigation techniques and results are inconclusive.

There is a contractor working in Alberta that is currently looking at ungulate repellence to road salt. It is a result of a contract where caribou are killed on Grand Cache highway due to licking salt. He is looking at putting a repellency to salt on the roads and testing it on ungulates in JNP.

The effect of warning signs on driver behavior is another issue of concern. We put up warning signs and big white elk signs but we have yet to test their effectiveness.

In order to go further, we need to have a roadway standard that will be similar to a roadway standard used for driver safety. There is a certain standard that you would use in terms of providing for driver safety such as salting and the use of other products, signage, etc. But we have no standards setting an acceptable level of wildlife-vehicle collisions. The plan is to develop a standard or a model for what is an acceptable level of wildlife-vehicle collisions given certain sets of circumstances. We know that we are not going to totally eliminate wildlife-vehicle collisions, but what can we allow as an acceptable level?

So far the number of wildlife-vehicle collisions was increasing until we stepped in and tried to do something in terms of the communication strategy. We have focused our efforts on modifying driver behavior without modifying wildlife behavior. We have had some successes recently and have recorded a 28% decrease in wildlife-vehicle collisions in 1996. We want to focus on components that don't make major changes but do make driver behavior changes. Although we can communicate with each other, we have a very difficult time when it comes to modifying our behavior in terms of environmental issues. We would rather use a technological component rather than build a fence in order to keep it simpler, more economical and maybe create a respect of sharing the space with wildlife and not blocking us out from it.

Question and Answer:

Q: You stressed the importance of speed on wildlife-vehicle collisions, what about visibility? You seem to know where the hotspots are on the highway as far as collisions and collision intensities, but could visibility be a factor there as well?
A: A factor could be roadway design vs. visibility. We are not going to make major changes and change the roadway design. We also don't want to make major changes in wildlife behavior so we haven't assessed those components.

Q: I noticed that you have two distinct segments where mortality went up in the summertime due to the volume of traffic. In wintertime, what is the amount of snow in the ditches? I know that the animals in heavier snow areas will migrate out onto the roadway simply because it is easier to get out there and move.
A: The majority of the Yellowhead highway is through montane area. The chinooks and the wind blows most of the snow away. An example is that since mid-February there has been no snow in the major portion of the Athabasca valley. Migration onto clear areas is significant in some areas where you go west towards Yellowhead Pass and they will particularly start to use the railroad. Especially moose use it as a travel corridor. But this does not occur in most places in the Athabasca Valley.

Q: Have you tried specialized signs to advise the public during certain seasons?
A: One of the most specialized signs we have gone to recently is a large sign with white elk on top of it telling people how many animals have been killed this year, last year and the record kill. One of the things I have found speaking with the public is that they have no idea the significance of the frequency of collisions. So if we left all those animals out on the highway rotting, we'd certainly all have an idea of wildlife-vehicle collision and probably reduce it.
--I was thinking more of a warning sign or people at the gates advising people that it is mating season.
--We could probably do that while traffic volumes are low during the fall. During other times of the year they get a handful of brochures and you see them thrown up on the dash and after they finish driving the highway, they may read them at the hotel room or not. However we could probably do that during the fall.

Q: Do you look at the variables between signs in that you could change the speed with the time of day, month or year?
A: Well that is what we want to do. We probably will remove the 70 km/hr zones for bighorn sheep because I don't believe that speed is a significant contributor to bighorn sheep mortality. What happens when you get bighorn sheep jams is that the sheep run out from between jammed vehicles and get hit. The vehicles are probably traveling at 30 or 40 km/hr and the same happens to black bears.

Q: Will the signs be controlled centrally or flip-sign?
A: We would probably just go out and change the sign with a flip-sign. That's what we have for our number signs. It's hard to assess that type of mitigation however it is worth using I believe, especially at the low cost of one sign.

Q: Is photo radar not allowed in the Park?
A: Sure it is, but one of the things with photo radar is that historically RCMP will focus their efforts during high traffic volume periods. They don't run radar at 3 a.m. Our traffic stats show us that at night the major user is large trucks. They will be unsuccessful at getting the large trucks. Most of their monitoring is during daylight periods when wildlife-vehicle collisions are low. If you are going to have a compliance strategy to focus on wildlife-vehicle collisions you wouldn't do that at one in the afternoon. I would do it at night and focus on large trucks.

Kootenay Parkway wildlife accident monitoring program

Doug Kerr

Parks Canada
Box 900
Banff National Park
Banff, Alberta, T0L 0C0
E-mail: douglas_kerr@pch.gc.ca

Keywords: GIS, highway 93 south, Kootenay National Park, mitigation, signage, wildlife-vehicle collisions

Abstract

Over the past year, a comprehensive review of signs on highway 93 south has been carried out by the Highway Service Center of Parks Canada in conjunction with Architect and Engineering Services of Public Works Canada. As part of this review, wildlife sign locations were reviewed against BCMoTH accident statistics and park wildlife statistics with interesting results. Using GIS technology, a sign plan has been developed as well as a monitoring program to assess effectiveness and other mitigation measures proposed.

Introduction

I'm talking today about highway 93 south (93S), 10 km of which is in Banff National Park and 98 km is in Kootenay National Park. About a year ago, I initiated a review of the signage on highway 93 and it was apparent that we needed to spend some capital dollars on the signage. The posts and signs were getting old. We have an ongoing program to repair the signs, but it was getting to be a big problem. It also occurred to me that most of the people that had designed the highway and sign plans were not only retired, but dead. So it was probably time for a review of the whole picture.

Working with transportation engineers and with public works out of Calgary and Ottawa, we focused on the whole sign plan for Kootenay and also on the wildlife signage which is a very important component. Our agenda for wildlife signage was to do an analysis of the accident data and develop an action plan to address problems and ongoing evaluation. For accident data, we used the BC Ministry of Transportation and Highways (BCMoTH) accident database and the Parks Canada database. Every time there is an accident that involves damages of more than $1,000 or personal injury, a report goes to the RCMP and eventually ends up in the BC database. If it involves wildlife, it is flagged. Parks Canada keeps very accurate records of all wildlife accident incidents and it doesn't matter about cost or who was injured. We wanted to compare results between databases.

Accident database analysis

Here is the BCMoTH database looking from 1988-1994 and there are 160 recorded incidents whereas there are 312 from the Parks Canada database (Table 1 & 2). Showing it on a graph, we have number of accidents over the time period and the kilometre distance starting at the continental divide on 93 to Radium Hot Springs at kilometre 92 (Fig. 1). There are some differences but in most cases there is a good correlation between the two data bases.

Using GIS, we demonstrated high hazard areas then plotted existing wildlife signage. Our existing signage is not necessarily in the right place (Fig. 2). The problem is that we go on perceptions. For example, in the Hector Gorge area there is a mineral lick that the goats love to come down to that because it is right beside the highway. We have an immediate goat jam. Our perception is that we have a wildlife problem there. However, statistically and based on the number of accidents that happen with wildlife in that area, there is not a wildlife problem there but a people problem. The goats sit at the side of the road and hardly ever venture onto the road. The people are running into each other as they stop their cars and that is the problem.

We also looked at drainage valleys. In almost every case along the highway you find that high wildlife incident areas coincide where drainages intersects the highway. It makes sense because of the animals' movement corridors and crossing points.

This is the Marble Canyon area in which we don't have wildlife signs up (Fig. 3). We have every other type of sign though as this is a very congested area coming down over the Vermilion Pass with numerous curves and there is a campground as well as a major day use area. The wildlife are using corridors that intersect the highway here. It just happens that this is a complicated place in the highway. It doesn't surprise me at all that this is a high incident site for wildlife.

Future action plans

We wanted to come up with an action plan and a new sign plan for 1998. Once we reviewed all the signs we calculated that we could probably spend $250,000-300,000 in 100 km of road to upgrade all of our signs. We only have about $70,000 to spend this year so we have to set priorities. Our priorities are all of the warning signage, curves, speeds reduction, wildlife etc.

We will be using our typical due diligence sign for wildlife incident areas. Our sign plan is for every area that we have identified as a high incidence site, it will be marked as a wildlife hazard area on both sides (Fig. 4). There will also be a distance listed so that drivers know that for the next 4-5 km that it is a high incidence site. It is important to get the message out about new signage. The group I met with yesterday consisted of companies involved in commercial transportation on highway 93 south.

We also want to follow up this program to see if it was effective. We want to do an annual update of accident statistics to see if we are making a difference. We also want to look at the effectiveness of wildlife warning reflectors and explore other low cost mitigation. In the Marble Canyon area there is so much there visually for motorists that when you throw wildlife into the mix, reaction time is reduced. If we push the wildlife further down the road where it is much more open with better visibility then they will probably have a much better chance of surviving.

We also talked about other sign options. Tony talked about an interesting idea of signage that you might be able to activate with your cell phone. Motorist observing wildlife can dial a number which would activate flashing lights on warning signs. There are many ideas to make signs more effective. We want to review the impact of new signs, look at the effectiveness and locations for elk silhouette signs and other low cost mitigation measures.

Conclusion

In conclusion, we want to reduce wildlife mortality, show due diligence to inform motorists of problem areas and increase safety for motorists. We need to get the message out to the public that we are putting a new sign plan in place for wildlife warnings and that we are serious. We want to continue to monitor the effectiveness of signage and other mitigation measures.

Questions and Answers:

Q: Are you going to do anything to get rid of roadside habitat or get the elk off of there?
A: I don't know how we ever could get rid of all the habitats near the road, or if we would want to.

Q: You mentioned that we need to test the swareflex reflectors in Kootenay. There may be an opportunity here if you were interested to get together and look at a section where they have been installed for a while and maybe do some covering experiments with wildlife contractors there.
A: The warden service in Kootenay would love to hear from you. One of our problems has been that we don't spend enough money maintaining these things once they have been installed.

Q: One of the best things that I have found for not hitting animals, especially in Kootenay Park, is driving lights. Does anybody know what the law is on that? My understanding is that they have to be wired to your high beams.
A: I can tell you that in 14 years of driving up and down highways in National Parks I have never hit an animal. A big part of it is awareness, knowing where the high incident areas are, which is where the signage comes in. It's like defensive driving. You have to anticipate a problem, especially at night. You get one chance to make your move or else you have elk all over your windshield. We wouldn't normally install those lights on a highway foreman's truck. We believe normal factory lights installed on vehicles are adequate especially if you drive the speed limit. Speed is a big problem in Kootenay.

Table 1: Kootenay Parkway Accidents Involving Wild Animals From 1988 To 1994 (Based on BC MOTH Accident Records)

	YEAR							
	1988	1989	1990	1991	1992	1993	1994	***Grand Total***
NUMBER OF ACCIDENTS	33	21	36	21	28	20	20	179
NUMBER OF INJURIES	1	3	9	7	4	1	2	27
NUMBER OF DAMAGED VEHICLES	32	19	30	16	24	20	19	160

Table 2: Wildlife Mortalities on the Kootenay Parkway From Park Records (1988-1994)

SPECIES	YEAR							TOTAL
	1988	1989	1990	1991	1992	1993	1994	
ELK	18	4	5	11	14	5	9	66
MULE DEER	15	9	4	3	4	3	1	39
WHITE-TAILED DEER	22	16	17	17	19	17	25	133
MOOSE	4	1	3	3	4	6	4	25
BIGHORN SHEEP	4	6	0	4	1	3	3	21
BLACK BEAR	0	0	2	0	2	2	2	8
COYOTE	8	4	1	0	3	3	1	20
YEAR TOTALS	71	40	32	38	47	39	45	312

Fig. 1. Kootenay parkway accidents involving wildlife, 1988-94 (based on BC Accident database)

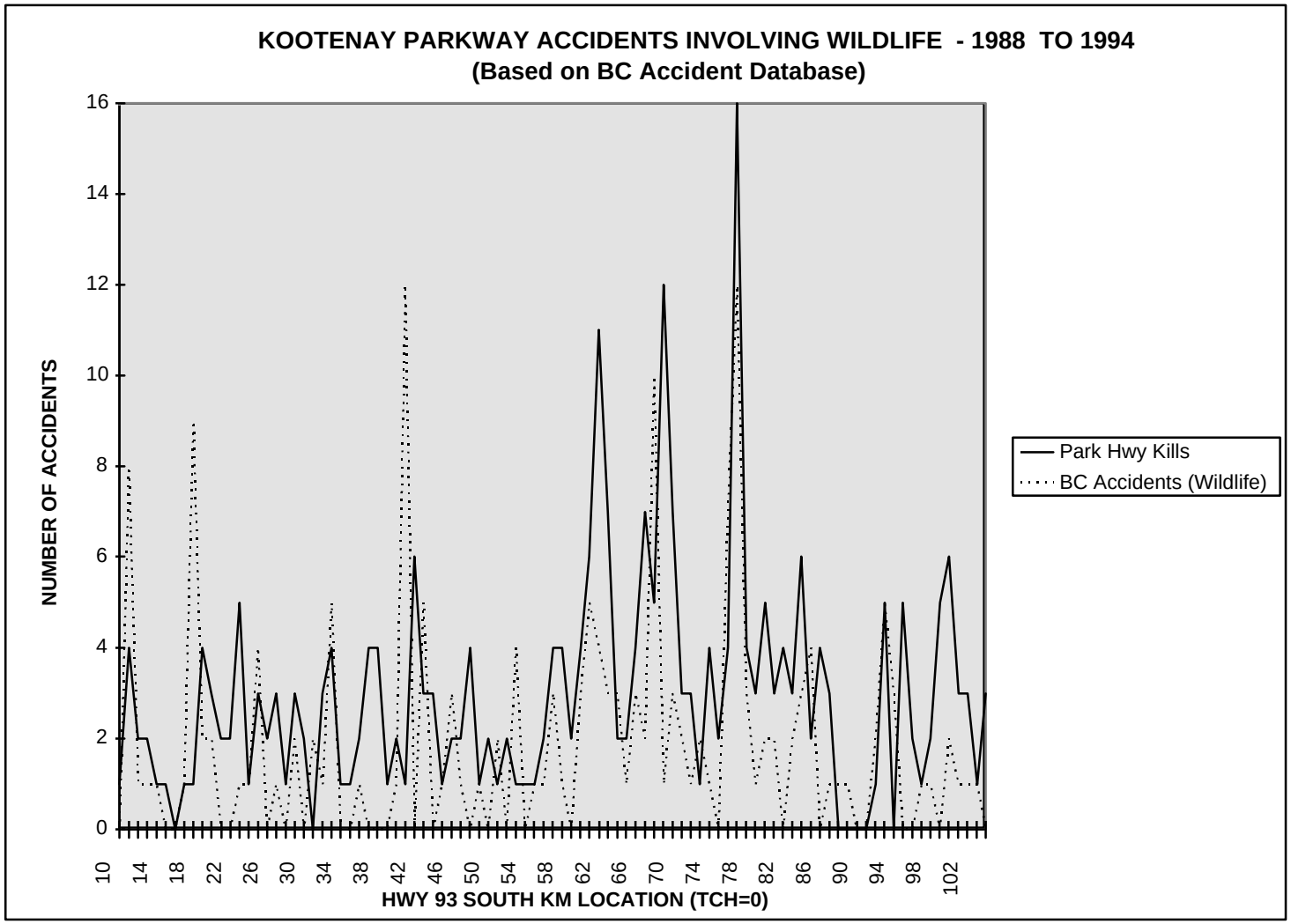


Fig. 2. Accident frequencies and sign locations on highway 93 S, Kootenay National Park.

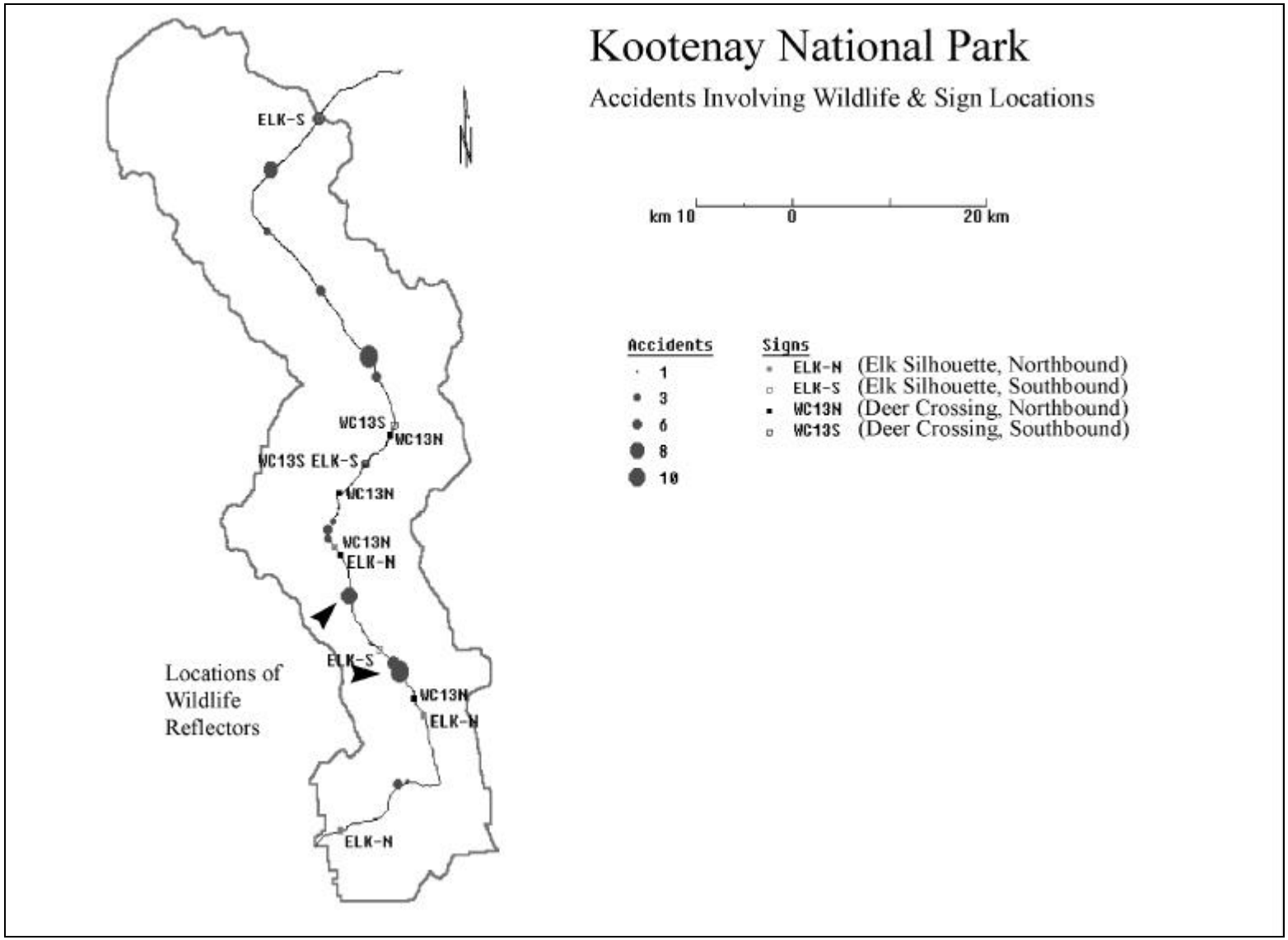


Fig. 3. Accident frequencies and sign locations in Marble Canyon area, Kootenay National Park.

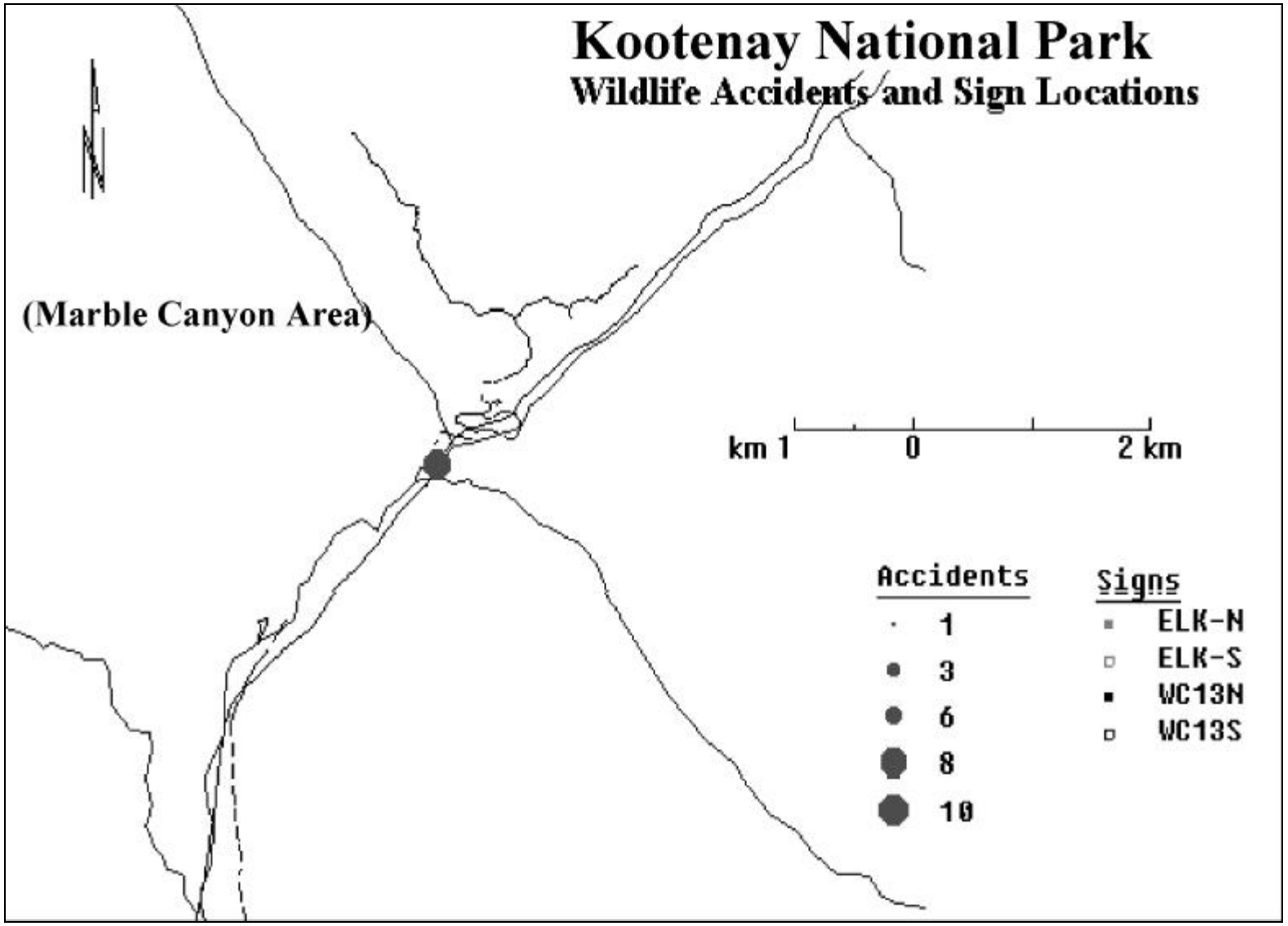
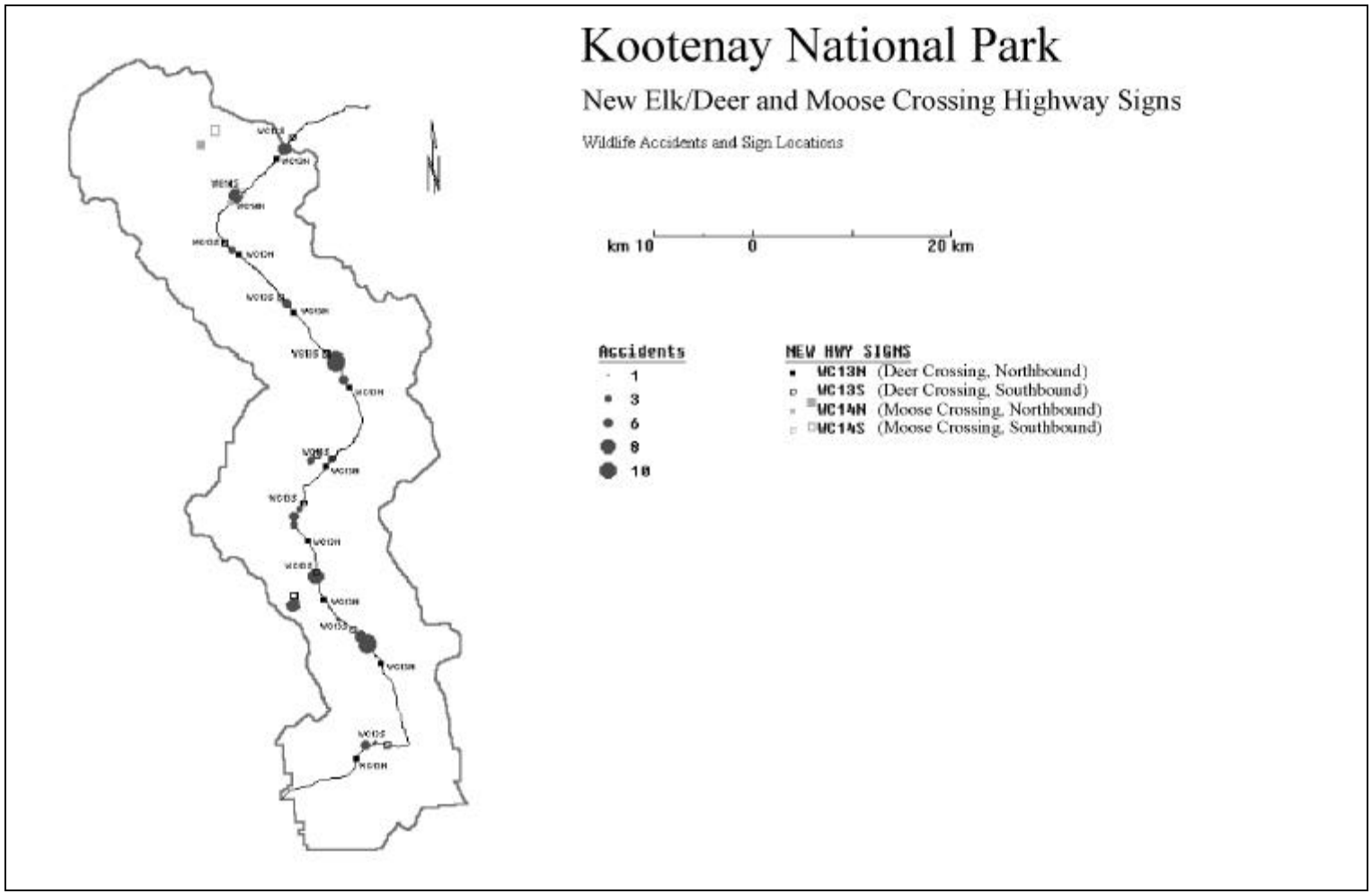


Fig. 4. Location of new elk, deer and moose crossing highway signs, Kootenay National Park.



SESSION 3.

Means of improving the quality of information used to make decisions regarding transportation effects on the environment

Identification of fish habitat adjacent to Canadian Pacific Railway using a GIS

Dan Meidl

Canadian Pacific Railway
401-9th Avenue, S.W.
Calgary, Alberta, T2P 4Z4
Fax: 403 205-9022

Keywords: Canadian Pacific Railway, fish habitat, GIS, impact assessment, mitigation, planning

Abstract

Canadian Pacific Limited has recently completed a GIS based habitat mapping project covering Canadian Pacific Railway's (CPR) mainline from Field to Vancouver, B.C. The electronic based program includes digitized air photos including topographic features which have been enhanced to identify sensitive habitat areas along the CPR corridor. The program includes information related to fish species present along the corridor, explanations of habitat sensitivities, preferred time frames for working within these areas, and notification of instructions to be followed by employees within the corridor. Training for field personnel is currently being developed to assist those CPR employees who will be using this information and who are required to work in these areas.

Introduction

This system has not been completed and we had hoped to have it finished by the end of March, but we have had trouble with some of the air photos. The system was developed by Enkon and the background program used is ArcInfo™, but that has been modified considerably by Enkon. The hope is that we are going to complete the system from Vancouver right through to Field and I suspect we should be finished within the next month or so. I will walk you through what the system is going to look like.

By the way, the size of the system has grown considerably since we started. We are looking at four subdivisions between Vancouver and Field and each subdivision is about a gig of memory. The computer that we are using today is a Pentium 73 megahertz which unfortunately is quite slow.

I will show you an example of how we would use the system. If we had to do some bridge pier work over a sensitive waterway in B.C., how would the system assist us? From the front screen we can put in the mileage. The bridge we are looking at today is over the Nicola River. The system will bring up information on the area, on the bridge itself and a lot of the fisheries information such as regulations. This is a digitized air photo. Glen, one of the environmental engineers who works for me, and myself made a high rail trip through the entire area and identified all the sensitive areas as we were going through. Most of our track is adjacent to water and most of it is along sensitive areas.

In the system, you can move the screen and move around. You can bring up the map adjacent to it. The air photos that we are looking at are based on 1:70,000, but you can magnify the area. In the lower mainland itself we were able to get maps that were 1:30, 000 so when you magnify the clarity is quite good. Any time you want to look it will show you the scale you are using and the UTM coordinates are shown wherever the mouse is going. We also have the 1:20,000 TRIM maps on here so if you want to see contours you can put it in there. If you want to change this photography it is a simple procedure of taking this photography out and putting in that which you want to use. It is not a permanent system if you want to update your system from year to year it is possible. The only limits to expansion are memory and money.

As far as the width of the habitat goes, it comes out of the guidelines for habitat sensitive areas. You can also go into the system and at any point calculate distances. The system will also be used for emergency situations. If we had a spill into the Nicola River, we could get boom lengths that we would need to place downstream.

The hydrology information at this moment is in the system but not connected. All species will be included for the area. From the first screen you can click on the area and it will bring up the aerial photo if you don't know the mileage you are at. There is information in here on culverts. Our culvert and bridge maintenance people will be using this regularly.

In the event that we wanted to do work on this bridge, we could click on the bridge and it will bring up general information on the front screen. It will give information such as historical data, bridge type, money spent on construction. As you walk through it, it will show money spent on maintenance throughout the years. On our trip we took photos of the bridge and scanned them into the system. Any other pictures can be added and scanned in. We also scanned in the actual historic pictures of the bridge itself. You can magnify parts to see them more clearly and zoom in on them.

As far as this project, we have now had a look at the bridge and the piers and we can go in and see are we in fact in a fisheries sensitive zone. If you click on the hatched area it will come up with the fisheries guidelines for fisheries sensitive areas in BC. It is more of a tool to allow employees to educate themselves. A lot of this information comes directly out of the guidelines. Enkon put in the relevant information. There is background information explaining what fisheries sensitive zones are and why they are important.

You can click on the approvals for fisheries sensitive zones to see if you need an approval for the area. There will be an attached application form in there so that all the information you need is right in the system itself. You can look at other related topics and guidelines such as bridge sand blasting.

Within our project we know that we are in a sensitive area and that we need an approval so we can go back to the list of documents and get into the regulations and policies themselves. There is information on the fisheries act as well as many others.
The next step on our project might be to consider what the construction windows are that we could go in and actually do work. There is all the background information. We can also go right to the list itself and it gives the exact construction window for the Nicola window and the reasons why.

We can also go into a list of contacts of who to talk to about the work. If these are field personnel, they are likely going to want to talk to someone within CP. We have the DFO

people listed for this area. If you go into a particular area it will tell you who to talk to for all the different issues.

We wanted to look at some of the environmental information adjacent to the bridge that we were looking at. It also has the waterfowl information in here.

The next step is, which is the most important step, the use of this information by CP employees. The field people are not going to have the computers to run the system. The roadmasters will be provided with paper copies of the air photos in their area and the written text. There will be training sessions. Most of the managers, environmental engineers, dispatchers and others will have it. The construction people will also require it. There will be a wide use on the railway but the training is key. I've been in touch with DFO and we would like to have them involved. We want to achieve a level of comfort with the DFO employees that we will be examining habitats and taking their concerns into consideration and they have been very supportive throughout the conceptual stage of this work.

Question and Answer:

Q: How come your data isn't in metric?
A: Because the bridge dates back to 1929, therefore the information is from 1929. Everyone in the railway is still converse with both systems. We still have all our mile boards across the system, right from Montreal all the way to Vancouver. Any bridge design that occurred in the last 10 years would be in metric. All of our right of ways are based on the old system and are all about 100 feet wide, our track section is about 22 feet wide. I think our reference will always be in miles, it is too difficult to change.

Q: In terms of your asset database, how many separate files do you have in here?
A: We don't know and would have to talk to our computer guys.

Q: Is it tied somehow into the actual performance? Are you going to have some way of monitoring how well people uphold these guidelines or if they do the work that this system suggests they should be doing?
A: We're going to stress the training up front. The monitoring will likely come from the specific managers within those departments. We are also monitored very rigidly by the regulators themselves. There will be follow-up. We will be updating this system all the time.

A multi-performance approach to identifying, advancing and prioritizing provincial and corridor level highway improvements

Mike Trickey

B. C. Ministry of Transportation and Highways
523 Columbia Street
Kamloops, B.C. V2C 2T9
E-mail: mtrickey@vines.gems.gov.bc.ca

Keywords: British Columbia, highway function, multiple account evaluation, performance measurement, highway planning process, Trans-Canada Highway, Trans-Canada Highway Corridor Management Plan

Abstract

In my presentation I will discuss the roles that performance measurement, deficiency analysis, multiple account evaluation, benefit/cost analysis, and public consultation play in prioritizing and advancing provincial and corridor level highway improvements. In addition, I will provide a quick status report on the Trans-Canada Corridor Management Plan (Kamloops, B.C. to Alberta border).

Introduction

In my talk today, I am going to give an overview of the highway planning process. It may sound dry and like there is no link to the environment, but there is and it happens in the multiple account evaluation (MAE) stage of the analysis. What I will talk about is how highways function, highway objectives, highway performance measurement, MAE, investment strategy development, and our planning process. I will then conclude with an update on the TransCanada Highway (TCH) Corridor Management Plan (CMP).

Highway classification system

With the recent re-organization of the British Columbia Ministry of Transportation and Highways (BCMoTH), we are now implementing a new business culture. The link of highways to the economics, land use, and social well-being of the province of B.C. is well established. The social economic status of our province does require the preservation of our highway functionality. Highways are designed for a variety of purposes. We have them broken down into strategic functional classification: primary, secondary or arterial highway. Each strategic category is then divided into a service classification based upon what type of facility best provides the service: freeway, expressway or major road. For example, a primary highway is a highway that serves cities greater than 50,000 people, holds greater than 10,000 tons of traffic per year, serves ferries with greater than 50,000 passenger kilometers per year, recreational areas with greater than 3 million visitors per year, connects major activity centers, joins adjacent capitals and has a strong provincial, national and international significance. It is meant to give access to a lower classification of highway, a secondary, which in turn gives access to an even lower classification, which then gives access to the land. The functionality of

a highway is not stationary and may vary with time. As society and economics change so must our highway functional classification.

Highways need to provide both mobility and access to the land. Mobility is the ease, speed, safety and convenience of travel. Access is getting to the land use. These two components need to be in a controlled balance to make this system work. If you look at the TCH from the Alberta border to Kamloops, B.C., aside from some of the geographic problems, communities have grown up around the TCH and this was not the initial intent for the highway. It would have been more appropriate if the communities were built off the highway with access roads to them to conserve the mobility of this primary highway.

Highway planning process

The keystone of our current planning process is the Provincial Highway Plan (PHP). The PHP will provide consistent standards for highway planning in the province as well as caps for our funding cash flows. The PHP integrates regional system plans and corridor management plans.

When we evaluate a highway, we look at objectives both provincially and within the Ministry. Provincial objectives include a safe highway system, the efficiency of movement of people and goods, and the realization of the following government objectives: public input, fiscal responsibility, environmental sustainability, community development, economic development and social equity. Social equity means user pay or regional distribution of funds. This type of analysis requires the making of some hard decision and knowing that for every decision you make there are concessions. Many of these provincial values are reflected in the Growth Strategies Act which is concerned with land use, preservation of assets, effective corridors and maximizing the existing planning resources we have rather than building incremental facilities.

There are two main Ministry objectives; maintaining the safety and mobility of the highway system and protecting the investment we currently have in our infrastructure. Right now we have more deficiencies than we are able to afford, therefore it may not be prudent to add more infrastructure as we already have enough trouble maintaining the assets we have.

Performance measurement

We use a performance measurement (PM) to assess the current and future performance of our highways. PM asks the questions is there a problem? and where is it?, not why is it there. PM goals include: customer satisfaction, infrastructure condition, fiscal reality, economic development, social equity, environmental sustainability and community development. In order to make these tangible and measurable we translate them to: travel speed, accident rate, reliability, and infrastructure condition. These are the performance criteria that we can monetize. We don’t put a dollar value on the environment, economic development or community development accounts. These non-monetized accounts leverage the monetized accounts in the determination of an appropriate improvement.

Once we have a deficiency, we proceed to problem definition. Developing a sound problem definition ensures us that we are spending money and effort on the problem and not a symptom of the problem. From problem definition we develop a full suite of solutions to solve this problem including a do nothing or minimum scenario for each case. Then we do a multiple

count evaluation on each option, looking at the monetized and non-monetized accounts associated with each option. Approved improvements then form the basis of a long-term investment/management strategy. Each time we cycle through our transportation system plans and corridor management plans we can audit out progress.

Some of the environmental impacts that we look at include: land use impacts, noise, energy consumption, emissions, wildlife, water pollution, site rehabilitation, visual impacts and special cultural and spiritual areas. We do not put costs on these accounts, although we have considered it in the past.

Trans-Canada corridor management plan

Now I will give you an overview as to what we are planning to do on the TCH. A Corridor Management Plan (CMP) is a tool to establish the role and function of a corridor, assess its performance, to preserve its current assets, and to implement improvement where warranted. What the TCH CMP is not, is a plan to four-lane the TCH or move it up to 110 km per hour. The plan is to look what needs to be done based on the performance measures that we have got and the function of that corridor from Alberta to Kamloops. We need to protect the current assets we have got there now before we go out and build anything new. We do it in partnerships with public and private agencies. When it comes to the multiple accounts, I will be asking a lot of people, environmental people and others, for their input. By doing this we will have to resolve all issues before the project is initiated. Out of the TCH CMP plan we will get a long-term 25 year investment/management strategy that we can move forward for funding and implementation.

We hope to have our kick-off meeting on this TCH CMP project in early May. The major milestones will be the kick-off meeting, the completion of the deficiency analysis and problem definition, options generation, multiple account evaluation and recommendation of options, and finally the investment strategy. TCH CMP is one of many CMPs throughout the province, each competing for precious funding. TCH corridor improvements depend on priorities set in the PHP which looks at where provincial priorities are and how much funding each CMP will get in the short and long term. In concert with preserving historic funding we also look at incremental funding cash flows to finance improvements.

By January 1998, work on the TCH CMP will be complete up to problem definition. By October 1998, the TCH CMP will have a short list of improvements ready to proceed, and by January 1999, the TCH CMP should be complete, although there is a probability that some constituent studies remain incomplete. Constituent studies are often required for large problems where there is a considerable amount of preliminary work required to assess a problem definition, such as Three Valley Gap or Kicking Horse Pass. Often constituent studies are so expensive that they are phased. If any TCH CMP constituent study is not completed by January 1999, the remaining work required for its completion will be phased in the investment strategy.

Questions and Answers:

Q: What do you mean by monitorize and accounts? Since your work incorporates people from a lot of different fields why don't you use different terms?

A: Everyone I present to wants the terms changed however this is not necessary.What is necessary is that there be a glossary of terms in TCH CMP. Over time it may be possible to standardize some of these terms. Sorry, I meant monetized not “monitorize”, which means turning everything into a cash equivalent. Account means what impact area are we willing to look at: financial, environmental, infrastructure condition etc.

Q: In B.C. we are moving to the Microbencost as the cost/benefit program and the reason apparently we are moving into it is because it is being adopted by many states in the US, by many provinces and by the federal government. I’m wondering - if Steve or the gentleman from Washington State are using Microbencost at all?
--I’m not aware of that
A: There are other reasons why we are using that, we are not just following the pack. We are using it because it works as a comprehensive tool to calculate a net present value and a benefit/cost ratio as well as generate CO_2 emissions for highway projects.
--I might add that Transport Canada initiated a study a year and a half ago of what provinces were using and we were having problems in asking them to try and rank projects and as a group - 10 provinces and 2 territories - we all jointly funded a pilot project and at the end we all decided that Microbencost was suitable. B.C. had a very active model. They all agreed to use one form so you can sort of compare projects across the country. This is a North American model that virtually everyone is using so that for things like NAFTA, etc. it is all compatible. I’m assuming that it will be extended into Mexico. The Americans are making the model metric for us.

Q: When I first heard of the CMP process, I was really excited about it from the ecological side of the accounts. Normally the highway projects come to us very quickly and in very short physical spaces. Often as biologists and ecologists we are looking at larger scale issues that cannot be addressed at that time-scale or physical spatial scale. I think this is exciting because finally we are getting the chance to have dialogue, input and discussions at the right scale and timeframe. I think this is very progressive.

Q: I have an observation. Any new changes take a long time to implement. You are talking a couple of years before the CMP is complete. It will be studied to death. By the time you get ready to make some recommendations, there will be a change in government or a new process in place and you will be off on another track. Do you see this as a political reality that the government of the day can use this to not address issues immediately and keep putting things off? From the federal side this happens often. At the end of a two to three year process, there is another election and if you are in, you do something to drought someone else’s problem. Do you see this happening because it seems to be a long time getting to where you will have something concrete?
A: It is an unfortunate nature of our business. Even more so, the communities along the TCH will be changing their politics and flavors. Everything is temporal. A lot of the things we are doing here make good economic and social sense and hopefully any government will have that appreciation. Politics may influence the accounts a bit, but to say that you don’t need to have a well developed business plan to run your business efficiently is unreasonable. It is common sense for an agency like the Ministry of Transportation and Highways to do the best it can to manage its assets. The TCH has had many past studies performed on it yet none were linked, nor did they consider many of the accounts. By today’s standards these past studies might not even be called planning. So the rub is ‘do you build on a legacy’.

Visualization for the environment

Jim Michal

Washington State Department of Transportation
Box 47329
Olympia, WA 98504-7329
E-mail: jmichal@wsdot.wa.gov

Keywords: computer-generated, design, photomontage, public involvement, visual impact, visualization techniques

Abstract

Design visualization is the art and science of "rendering" an image of a proposed site, facility or structure before any construction takes place. Computer technology is used to manipulate original images of scene(s) to create an "after" image(s) for presentation via color prints or plots, videotape or the Internet. Photographs, videotape, 3D models, and animation can be used to create a number of different design visualization products. Presented are a number of multimedia examples of design visualization to illustrate how this concept and technology could be applied to environmental issues.

Introduction

I'm going to talk about how important visuals and graphic images are to how we describe things. I think as Pat said yesterday, this is a graphic's world, everything is visual. Angela used visual images of signs in the survey sent out in BC. This morning Mike talked about visual impacts as part of the environmental impacts. I'm going to talk about design visualization and unfortunately most of the examples I have today are engineering types of projects, not environmental projects. Although you heard that I work in the environmental and engineering service center, that is a big organization in our department. I think we have 35-50 people in our environmental unit and they are very interested and keen in using visualization techniques to illustrate examples of problems. You can conceive how this type of technology could help you do your jobs better.

The problem or dilemma that I was trying to solve with these design visualization products is the ability to be able to explain to the public or others within your organization what you are trying to create. It would help the highway folks explain to the public how plans would affect their businesses and homes and what it would really look like much more effectively than 2-dimensional plans or photographs with lines on them. It's really hard to explain what the visual impact would be in two-dimensions. My focus when starting this service about four years ago was on public involvement. We do have a very intense public involvement process all the way from the planning through to the construction. I did a pilot test to prove the technology. I presented a white paper to management with an implementation strategy for developing and doing these kinds of services within our department.

The key to this whole thing was that we began to develop 3-dimensional models of things. The software allowed us to collect survey data in 3-dimensions. The first product I defined is a cut

and paste photograph. We manipulate the photograph with the software Photoshop™. The second is called “photomontage” and is a 3-dimensional model. We also have the ability to use video and overlay images on a piece of rolling videotape. I have an example of an animation here that is totally a computer model and does not even use photographs. Sometimes the public doesn’t relate as well to a model as to a real photograph of the environment they are familiar with. There’s a place and use for all these different products. It takes a lot of time. It takes 30 different images for one second of animation. We can also do strictly video production as well. We don’t have any video editing equipment, it is all done on computer and disc.

Now I will give you some examples of what a cut and paste is. This one I downloaded from the Internet. In a rural area, this is a good example to show how we might be able to work with the community. This is a place called Index *(sp?)* in Washington and this is a very historic bridge and the community has grown very attached to it and like the look of it but the structure is very old. It doesn’t really have the carrying capacity for a bus. We did a cut and paste photograph and showed what an alternative might look like. We had several options and the engineer used these in public community involvement to show them what these alternative are. The idea of cut and paste is to find an example of an existing image that you want to superimpose an image on.

Here is another cut and paste in Spanoa *(sp?)* near Tacoma and in this region they wanted to build a bicycle path. We created an image with a grassy area and sidewalks and the bike path with design visualization. There was a site similar to this right in downtown Olympia so we took a picture of that and imposed it on the picture of Spanoa to create this image. When taken to a public hearing, business owners were very enthused about this. These pictures not only helped sell the project, but also the department and they funded a project that cost more money than what they originally anticipated.

Here is another cut and paste. We have a severe growth problem on the west Coast of Washington state. We are very dependent on our transportation infrastructure. We are a multi-modal agency concerned with rail, roads and even airway stuff plus a marine division. One of our recent concerns is the increase in train traffic and it is causing a lot of traffic jams and there is a lot of focus on how to remedy this. We created a cut and paste to portray to the public what a change would look like in that area. We found an example that we could paste in and it only took two hours. The trick was finding an example that perfectly fit this area, so you can’t use cut and paste all the time.

Here is another example in Newport, close to your border here. It is a proposed project to do a little couplet to relieve congestion downtown. They have a local improvement district which is a funding mechanism of an association of businesses in the community along with the State of Washington so it is a multiple funding partnership. The mayor of this organization approached us about doing this to show the business owners what it would look like. We created an image from an example in Spokane that happened to fit the same arrangement. We also added details with photo manipulation.

Now I’m going to go on to the photomontage which is a 3-dimensional model. This is in Squim *(sp?)* which is on the peninsula and it is a retirement community and a volatile area for public involvement. We have done a design here with our Seal software. We took photographs with the project engineer in 11 different locations and we get a coordinate in each quadrant of the

picture. If we don't have a signpost or some reference there that we can get a coordinate of, we put cones down for reference points. The surveyors will develop an x, y, z coordinate for the different control points. We can then match the control points in the computer model on top of photographs to render an accurate image of where the facility will actually be. The bridge in the photograph is another cut and paste inserted in there. It is a pretty dramatic and effective photograph showing the impact to the area.

Here is another 3-dimensional one in Wenatchee with traffic signals and such. We rendered it first with green grass and the project engineer clarified that most of the year was brown grass so we changed it to brown.

Here is an example that could perhaps be applied in an environmental area because this is a widening, straightening out curves safety job. This one has a wetland impact.

This one is in Seattle showing Aurora avenue and the area needs a pedestrian overpass for the citizens to cross the road. Our architectural office developed two conceptual designs and we built a computer model in our drafting software and we created this image. The neat part about models is that from whatever view or angle you take the photograph, you can rotate it around as opposed to cut and paste. There is a lot more flexibility. We also did some perspectives from the crossing as well. The software is sophisticated enough to do different times of day with shadowing or seasons.

Another type of modeling process that we built in our CAD software is our ferry facility. They wanted to build an improvement that could load and unload two pedestrian ferries at the same time; same kind of a process.

In the news right now, there is some controversy about the Seattle stadiums. We were working with these groups and this view is of the access ramps that are proposed that our facility build for this stadium. We didn't have a computer model of the stadium, but they had a 3-dimensional scale model built so we took photographs and pasted in the ramps.

So how does this work? It works just by photo-manipulation with software. One difficult part is alot of the times when you remove an image you don't know what is behind it. Therefore cut and paste doesn't always work if there are too many obstructions.

For photomontage, we meet with the project engineers to know and understand the project and where the controversial areas are. We identify locations for photographs as well as the perspectives. We need 3-dimensional models if there are some. I don't want to elude that this is only for urban environments. We also have applied this many times to rural projects. Some of the uses are that it doesn't show much change at all. Some of the things with the Indian Reservation for example, is that they were concerned with the widening of the highway disrupting their land. So sometimes we are trying to show very little change. Sometimes in the smaller communities when we are doing a project like widening a 2-lane highway, they think that we are building a 4-lane highway and they don't understand until they can see it. So there are a lot of logistics in doing these types of photographs.

We sometimes do videos as well. When taking these photos, we take them to a 1-hr developer and then we sit down with the project engineer and that person picks the preferred scenes for angles, colors, etc. Then we need to match the survey points with the camera locations and those kinds of things. Printing is an important aspect of this. We

contracted out to commercial services originally but this is very expensive so since then we have bought equipment to do it ourselves.

Unfortunately our bridge division has not yet used our 3-D designs to design their bridges. We'll hopefully be moving that way.
Our environmental group always has the problem of explaining to designers how to mitigate a wetland or that type of thing. Here is an example we developed for them of before and after photos. They use design visualization cutting and pasting things to create an image that is desirable.

This is an animation done for our bridge division. It has sound from our library of sounds that we created. We showed it to our commission to demonstrate the seriousness of the Alaska Way Viaduct in Seattle and what might happen with a severe earthquake. We used this 15-20 second animation to show the impact it may cause. We used a lot of photographs from California earthquakes to show what the stress fractures might look like at different joints in the structure.

Question and Answer:

Q: What would be a ballpark price for you to get where you are?
A: You could start at a pretty low level with some software like Photoshop™. I would give you a ballpark figure of $10,000-12,000 to have a pretty suped up computer, that would mean a lot of memory and disk storage capacity because you need a lot working with photographs - you could start with that even creating images. For printing you could start with an 8.5x11 color printer which are reasonable these days like a couple of hundred dollars. In some of these projects we create a little project book for the public to show these displays. It could be very effective at that level. We've gone beyond that and spent a lot of money for the animation equipment and we found that to be very valuable too. But I'd say in total investment we're probably up to around $50,000 - 80,000. The printer we obtained was around $10,000, but the clarity and images it portrays are amazing. We can create an image the size of that poster without losing any clarity. This is effective when doing displays.

Q: Why was Washington state chosen to do this now? Why was this not contracted out?
A: The reason is because it costs a ton to contract it out. I have three staff people and have invested in some equipment, but if you asked a consultant to do it they charge an extreme amount. For example for them to do a video, it costs $1500-$2000. If I have the equipment it doesn't cost me anything. It is 2 to 3 times more economical that using a consulting organization for the process and the same goes for printing.

Q: There have been some pretty impressive visualizations of volcanic hazards in Washington State on the movies recently. Have you found links that you can do to what the movie industry is doing for hazards related to the roads?
A: I'm not aware of any. There may be some on our homepage but we certainly haven't done any of that kind of work. Obviously the techniques and principles involved are very much like the movie industry are using.
--- We're talking some of these same bridges. For example the Toule river bridge did not go during the Mt. St. Helens eruption but was very close and I was wondering whether you had analyzed the effects?

--- Not my organization, but this tool could be used to do something like this. My staff has a tremendous, positive response out of this. We started off not having this type of capability at all and we are so backlogged now that we are several months behind. It has been so impressive that our management has agreed to supply some more staff to us and we have petitioned the legislature to give us more staff. One of them is specifically going to be working on environmental items for our environmental unit. They like to be able to explain in a visual manner the things that they are doing.

Q: When you take these photos to the public, are you sharing with them also the costs?
A: My job is just to supply the project engineer the visuals they require.

Bibliography with regards to the effect of linear development on the environment

Martin Jalkotzy

Arc Wildlife Services Ltd.
2201-34th Street S.W.
Calgary, Alberta T3E 2W2
E-mail: mjalkotz@canuck.com

Keywords: bibliography, database, highway, linear developments, railway

Abstract:

We are currently preparing a bibliography on the effects of linear developments on wildlife, particularly large mammals. Electronic databases from libraries and on-line have been searched. Keywords for wildlife include: mammals, birds, reptiles and amphibians. Some linear developments include roads, trails, power-lines, pipelines and railways. References were downloaded into a ProCite™ database. There are currently more than 2,100 articles with abstracts. The report is made up mainly of species or species group summaries. Within each summary data are divided into six disturbance type categories. Completion is planned for June 1997. Soon thereafter the document will become public and available on CD-ROM.

Introduction

Currently, we are putting together a bibliography on the effects of linear development on wildlife. It is quite a broad topic. The contract is with the Canadian Association of Petroleum Producers (CAPP) in Calgary and they are an umbrella group for all oil and gas firms in the country. They are mostly interested in the wildlife and linear development that their companies deal with, particularly large mammals and the kinds of issues that they are dealing with in environmental impact assessment.

Methodology

To get the database put together, I searched a number of electronic databases that are available through libraries and online for articles on linear development and wildlife. For keywords for wildlife I used mammals, birds, reptiles and amphibians. As far as linear developments it included everything from roads to trails, power-lines, transmission lines as well as railways and many more. I think there were 30 some keywords.

Once we did these electronic searches, we downloaded all references into a ProCite™ database. Then we waded through them and annotated them. Right now there are over 2,100 articles in the database and almost all have abstracts attached in the database. In each record we can put extensive notes.

Literature summary

Once assembled, CAPP wanted us to do a summary for them. We divided it into three sections. The bulk of the report is made up of species or species group summaries. An

example group would be medium sized carnivores such as lynx, bobcat, fisher, marten and wolverine. We would look at kinds of effects that linear developments have on these species and summarize them.

Within each species summary, we organized the data using categories describing the kinds of disturbance. We expanded on Bruce McLellan's five categories into: 1) individual disruption - a car moving down a road and an animal moving away; 2) social disruption - moving bear number 16 from his home range into the backcountry affecting the social structure of the bears out there; 3) habitat avoidance and displacement - the avoidance of a linear corridor by the species; 4) habitat disruption or enhancement - the actual removal of habitat. For example, a road or a powerline that conceded to clover which is obviously better for some species; 5) indirect or direct mortality - shooting, poaching, access allowing hunters in; and 6) population effects.

The other two sections look at the disturbance data from two different perspectives. The one is from the perspective of the type of linear development. For example what kind of effects do roads have on all wildlife and summarizing that. The third is type of response.

It will be public document but I'm not sure when. The final format is up in the air. The database is big so it will probably be on CD-ROM. I don't think there will be a paper copy. It should be ready sometime in June 1997. If you would like to find out the status of it, get a hold of Rob McManus at CAPP.

Questions and Answers:

Q: Are you aware of the Road Rip bibliography?
A: We started with that. We had a couple of cooperators working with us. Ian Ross and myself, that's our wildlife service, that's my company. We had a librarian working with us as well as Paul Paquet who is with the WWF and his own consulting company. He got a hold of Road Rip for us. I hope they cleaned it up because I could hardly use it. It is a bibliography being worked on by a lot of people in the United States. It has over 6,000 references in it. It would have taken me more work to clean that up than start from the bottom.
-- I understand there is a lot of gray literature.

Q: What would be the distribution of the report? Do you know if it will be going to university libraries?
A: It hasn't been decided but I will be pushing for distribution like that. My wife is a librarian at the University of Calgary so she'll make sure it's there! CAPP hasn't committed to the price yet.

What is the Columbia Mountains Institute of Applied Ecology?

John Woods

Parks Canada
Mount Revelstoke-Glacier National Park
Box 350
Revelstoke, B.C. V0E 2S0
E-mail: john_woods@pch.gc.ca

Keywords: applied ecology, Columbia Mountains, information exchange, not-for-profit society, resources management, training, website

Abstract

The Columbia Mountains Institute of Applied Ecology was started in 1993. It is an institution focusing on management issues, primarily questions where better information is needed to make decisions. It is a not-for-profit society and has it's own written mandate. The Institute is to facilitate applied ecological research, provide specialized training in ecological research methods where there is a void, and serve as a forum for exchange of information. We have just produced a *researcher's handbook* for guiding new researchers in the region. We are actively sponsoring workshops, such as this one, and have opened a DNA extraction laboratory. A CMI website is in the process of being set up.

Introduction

I'm going to take a few moments to explain what the Columbia Mountains Institute of Applied Ecology is. In the name, I would like to stress the word applied. This is an institution focusing on management issues. This is not research in general or research for academic purposes only, it is always for things with an applied side. Of course you could always say that every bit of research has an application, but we wanted to make it clear that our focus was to be in the area of management questions where better information is needed in order to make the decisions.

This group started informally in 1993 because we noticed that there were so many projects happening in and around our area both with consulting companies and different levels of government. We would have biologists working on certain projects not knowing that just a few miles away someone had already done a similar project previously and because of poor communication they didn't know the other work had happened.

In 1993, Bruce McLellan and I invited 15 other people to a meeting to tell each other what is going on here. Thirty-three people showed up that first year. Every year we've held an annual meeting of researchers and managers involved in the area, we've had more and more people show up. We've been encouraged by this and figured that there must be a need since people keep showing up.

In 1996, early last year, we decided that this was as far as we could go with part-time energy between projects. We felt that in order to expand and do more things we had to have more structure. So we incorporated as a not-for-profit society within the province of B.C.
That has a number of advantages including allowing us to take in money, to take in, hold and disperse funds. The institute has a written mandate. One of the advantages of having a new organization is that you don't have to try to write your mandate for your old organization. We were able to write down the mission statement from the start. The missions are very straightforward.

First and foremost it is to facilitate applied ecological research and is not a lobby group for any particular point of view or agenda other than good information. Anyone can belong.

Secondly, it has a mission to provide specialized training in ecological research methods where there is a void. Where there is new techniques or a problem and it is necessary to develop something to proceed research in a coordinated fashion.

Thirdly and not lastly, to provide a forum for exchange of information that is coming from the hopefully improved science - an interchange between science, management and the public.

There are these three prongs to the mission of the Columbia Mountains Institute. I've often been asked what is your area? Well it is around here, which is very big. You could say the basin of the Columbia River but you notice that we have had talks from Banff and Hinton and that area and we just had a talk from Washington state. So "here" is a very loose terrain but we decided we had to have geographical orientation but we don't feel limited by that orientation.

Initially, we had several corporate sponsors who provided some lump sums to allow us to hire clerical help. These sponsors represent a number of different organizations. The Columbia Basin Fish and Wildlife Compensation Program is a special fund that contributed money to us as have the Ministry of Forests for the province of B.C. and Parks Canada. The Revelstoke Community Futures Corporation loaned us some money to help us out. The Revelstoke Community Forest Corporation, which is a city-owned forest company also provided some funding for the Institute.

We're here primarily because there are a lot of the issues revolving around here. We are in a sense a bit of a microcosm of many of the major issues of this part of the world. Forestry is a major employer, we have the mainline of the CPR, the TCH and we have significant landmasses of protected areas. This area, the Columbia Basin and it's rough edges, has a lot of what is going on in B.C. happening here. It brought a critical mass of people together. Bruce McLellan who was one of the co-founders of this idea works for the Ministry of Forests and is here on account as a research scientist.

Now what do we do? The projects that we have done to date include this annual researchers get together. Basically this is a show and tell and is probably the most important part of what we do each year. We hold an annual researchers meeting where everybody comes that we can get to come. That is working in the area or planning to work in the area. They can tell either how their project is going, has gone or how they would like it to go so this is shared across agencies.

We have put out two newsletters in the last year. We have put out more than that previously but since we have become incorporated, the plan is to produce two per year.

A major new development that we have just produced is a *researcher's handbook*. I have the first copy here. This is a guide to the agencies, the maps, GIS systems, the people, the permits, safety issues and just about everything you would need to do research around here. Bruce McLellan and I are really keen on this one because this contains the answers that we get plagued with. For example - who do we get a Park permit from? Who has the GIS? Where do I find the maps? Is there a herbarium? What are people working on around here? This is now finished and is available to anyone for free provided they get it over the internet. I will send you word file to download. If you want a physical copy you will have to pay the price of the photocopying.

We sponsor workshops just as this. The model for our workshops is that we charge just enough money to cover the costs of hall, food, clerical work, etc.

Earlier this year we had another workshop called, "The application of DNA fingerprinting to field ecology studies", and we had it in the same room. It was oversubscribed, we had 80 people attending and we could have had 200 if we had opened it up. We have produced a workshop summary from that get-together on DNA. We welcome helping anyone who has applied ecological research issues that would be suitable to deal with in a workshop format. Please contact us and we will try to help.

Also this past winter we opened a small DNA extraction laboratory. This was opened because our members had developed some new technology for DNA fingerprinting and in order to overcome a bit of a bottleneck in lab processing it was to the advantage of everyone if we hired a special technician ourselves and at low cost did the extraction of DNA material. That was an interesting sideline. We don't in the long-term want to set up little businesses, this was just a temporary effort to help the membership.

Also in the last year with the closure of the Glacialogical section of the National Hydrological Research Institute in Saskatoon, we've had Mindy Brugman come here from Saskatoon and join the Institute. She is very active in trying to keep going the glacialogical and the climate change initiatives that the Hydrological Institute once had and Mindy is part of this group we are putting together. We see tremendous application of Mindy's work on climate change and the hydrological cycle to ecological problems. I know we've talked to some people over the past few days about how climate change models might affect your notions on bridge standards for example.

When you develop a not-for-profit society in B.C. you have one year to get everything organized. In that year you have an interim board of directors of which I was Chair for this year. The idea is to get everything together so you can have a first annual general meeting where you have a elected board of directors. Our annual general meeting is April 30 here in Revelstoke and at that meeting we will move from the intern board to the elected board. We are also by the end of the month going to have our own website. This will be a mechanism allowing you to download the handbook, biographies of various researchers and querying the various information initiatives happening in the area. We're really looking forward to that because right now we are getting many calls and faxes that require clerical help to answer. The net will cut down on the labor.

If you would like to be a member, the Institute is open to anyone. The only entrance requirement is that you are interested in applied ecological research and applying ecological knowledge to management problems. You can be a consultant or private individual or any level of government or corporation.

We try to keep it cheap. You will notice the student fees are $5.00 and everything we do is much cheaper for students. Workshops are much cheaper and you can get into any workshop for $75 with a regular job and is only $30 for students. Our next meeting is our annual general meeting which is April 30.

The initiatives of the members determines how the Institute will go. If you have a good idea put it into action. The “you” is “we”. We need both ideas and participation and for communication, our internet address is by far the best way. It allows us to respond to you very easily without snail mail and we can send you files over that address. By the end of the month we will have our website address. Potentially some of the results from this workshop will be on the net.