Long-term monitoring and DNA-based approaches for restoring landscape connectivity across transportation corridors

Final Report to the Woodcock Foundation

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Western Transportation Institute
Montana State University-Bozeman

November 2005

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Final Report

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Name of organization completing report:
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Have there been any changes to your organization's IRS 501 (c)(3) not-for-profit status since your request for this grant? **No**

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"Long-term monitoring and DNA-based approaches for restoring landscape connectivity across transportation corridors"

Check one: General operating_____ **Project support__X__**

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CONTENTS

Summary

Canada's Rocky Mountain Front harbors the richest diversity of large mammals remaining in North America. This landscape is among the continents last remaining undisturbed natural areas, and provides a transboundary linkage with the United States. However, anticipated growth in population and projected highway improvement plans, coupled with the resounding concern for maintaining regional connectivity has generated keen interest in appropriate conservation tools and applications to mitigate these impacts on biodiversity. Our work is specifically designed to provide transportation and land managers with practical conservation applications for addressing the diverse issues linking transport, ecology and local communities.

Our work during 2005 consisted of four main activities. We summarize the results of each activity below.

(1) DNA profiling of animals using wildlife crossings in Banff National Park
As part of a 2-year pilot study, our aim was to devise a simple, non-invasive, cost-effective method to systematically sample and genotype of hairs (DNA) "captured" from passing carnivores at wildlife crossings. This novel, DNA-based approach has the potential to provide unique and highly valuable information regarding genetic interchange facilitated by crossings in a relatively short period of time, without ever having to capture or see an animal.

Methods - In 2004 and 2005, we piloted a DNA/hair-sampling system at two underpasses on the Trans-Canada Highway in Banff. Our hair-snagging system consisted of two strands of barbed wire spanning the width of an underpass. A high-adhesive string was intertwined to enhance the efficiency of the system to obtain hairs with sufficient DNA for analysis. As our target species were carnivores, primarily bears, the strands were suspended at 35 cm and 75 cm above the ground. Hair left on the barbs or string as the animal passed through the structure was collected daily and sent off to a genetics lab to identify species, individuals, and their sex. The hair-sampling systems were video-monitored 24-hrs a day to assess the success of the technique and to watch how wildlife responded to the slightly modified underpasses. This video footage allowed us to identify and correct any design flaws, or negative impacts on wildlife. We set up the DNA/hair sampling system at two Banff underpasses, as in 2004. Our 2005 field season was conducted from late-April to mid-August (3 ½ months of monitoring).

Performance criteria – The critical field data we sought in order to properly measure the performance of our method included: 1) how many animals approach the underpass with the DNA/hair-sampling system in place? 2) what was their behaviour? (avoid it or pass through), 3) of those that passed through, how many left hair? The hair samples we collected in the field were sent to the Wildlife Genetics International (WGI) lab in Nelson, British Columbia. Results of the molecular analysis would also provide key data on assessing how efficient our method sampled hairs with extractable DNA? (i.e., DNA extraction success rate). Of less importance for this pilot study, but certainly curious was to know how many individuals used the two underpasses during the pilot study, and how many were males and females?

Results - *DNA/hair capture efficacy* – We only report on DNA data collected from 2005 because in 2004 we tested several DNA/hair sampling systems. The system used in 2005 will be used in

a future study implementing the piloted method by measuring gene flow of grizzly and black bears using wildlife crossings and determining levels of connectivity needed to sustain populations (see report).

During the 2005 field season, carnivores approached the two underpasses 56 times; 43 approaches were by bear species (24 black bears, 19 grizzly bears). Bears turned around or avoided the underpasses less than 10% of the time; 2 of 24 black bears and 1 of 19 grizzly bears. The hair capture success rate was high, for both bear species, greater than 90% of the time they passed through the underpasses they left hair. For grizzly bears, 94% of the time they used they underpasses we were able to capture hair. Cougars can easily jump over the DNA/hair sampling system, but in 2005 they used the underpasses five times. Three out of five times cougars used the underpasses we obtained hair samples. Single wolves avoided the underpasses the first four times approaching; however, each time the lone wolf successively came closer to the DNA/hair sampling system. On the fifth and subsequent approaches the wolf passed through the hair-sampling system with little or no hesitation. We obtained hair samples from the wolf during 3 of 5 times they used the underpasses.

DNA profiling of individuals using crossings – A total of 56 hair samples from 2005 were sent to the WGI lab for identification of species, individuals, and determination of sex of the individuals. Thirty-six of the 56 (64%) samples were from bears; 20 samples were presumed to be from grizzly bears, 16 from black bears. We also sent 3 hair samples from cougars, 3 from wolves, and 14 "unknowns". Some of the 'unknown' samples proved to be from carnivores. From this point on, we will limit our summary to the bear species as that was the primary focus of the pilot study.

The hair samples from bears had a high rate of success for DNA extraction as useable DNA could be obtained from nearly all of the samples (17 of 20 for grizzly bears; 9 of 12 black bear samples). For both bear species, 81% of the samples had sufficient DNA to allow genetic profiling.

To determine the actual number of individuals using the two underpasses, the sex of each individual had to be determined. We obtained hair samples from 7 male bears (4 grizzly, 3 black) using the two underpasses, while 19 samples came from female bears (13 grizzly, 6 black). More than one sample could come from the same individual. For example, the same bear crossing on different days or two hair samples from the same bear passing one time. A total of 9 different bears used the two underpasses in 2005; 5 different grizzly bears (3 females, 2 males) and 4 different black bears (2 females, 2 males).

Conclusions – The results we present are undoubtedly very positive. The DNA/hair-sampling system developed during the 2-year pilot study has met all of our performance goals and criteria. This was clearly demonstrated by (1) the high number of bears approaching the underpasses, (2) the high number of bears actually using the underpasses and leaving DNA/hair samples, (3) the high rate of DNA extraction from the hair samples, (4) the number of actual individuals using the two underpasses, and (5) the number of female and male bears using the underpasses. It is important too remember that this sample was obtained from only 2 of 24 wildlife crossings on the TCH during a 3 ½ month period.

Our system has clearly proven to be a powerful, non-invasive technique capable of providing critical information regarding genetic interchange facilitated by crossings, without ever having to capture or see an animal. We look forward to advancing our knowledge of methods and research into the conservation value of crossings by measuring genetic and demographic connectivity. We are confident this work will advance our understanding of the utility of cross-highway corridors in maintaining viable wildlife populations and effects of habitat fragmentation by roads. It will provide practitioners and managers with much-needed information and enable well-founded decision-making with regard to wildlife passage placement, design and functional criteria. The results that we seek will provide a sound scientific basis for effective planning, policy and implementation. Perhaps more important, it will inspire confidence in individuals, agencies, and society as a whole that transportation impacts on wildlife and biodiversity loss is worthy of substantial and continuing investment.

2) Long-term monitoring and data collection

The long-term monitoring has demonstrated it's multipurpose utility in meeting transportation and resource management needs. Monitoring data from the 24 wildlife crossings has aided Banff National Park management in fulfilling a key objective of the park management plan – restoration of corridors and predator-prey relationships. The weekly monitoring has served as a bellwether and indicator of wildlife population status and trends, emulating one, long, multi-species, population monitoring transect. The long-term data will be used in a time-series analysis in 2006 looking at wildlife response to crossings and their attributes during a decade (1996-2006) of monitoring. This analysis will provide greater refinement and detail to guidelines we have developed to date from the Banff research.

3) Dissemination & development of science-based information

Publications – Scientific/Technical – 6 publications from our Banff research have appeared or will be in international, peer-reviewed scientific journals in 2005. Two of the publications are chapter in books being published by major international publishing companies (Cambridge University & Springer). Two additional publications were non-peer reviewed.

Media attention (press, web-based, television, radio) – Six articles about our research project appeared in the North American press, two in web-based publications (msnbc.com, stateline.org), two television interviews were made (CBC Calgary, Tokyo Broadcasting System), and one radio interview (CBC-French).

Presentations – Scientific/Technical – Four presentations of our research project were made at international conferences (Arizona, California, Portugal, Wyoming).

Presentations – Public **–** Three public presentations were made, including the Banff Research Updates Speaker Series and to the International Union for Conservation of Nature (IUCN) World Commission on Protected Areas.

Education – Academic & Technology Transfer – Collaboration has begun on three academic research projects and two technology transfer activities.

Education – Public Awareness and Information – There have been five different activities developed around our research that have been a part of Parks Canada's visitor education program and five other public outreach and education initiatives made by our research project to external groups. A particular importance is notification of the *Whyte Museum of the Canadian Rockies* approving our special project to develop a multimedia exhibit on wildlife crossings and research that will begin in May 2006.

Our long-term research continues to be a critical source of information and guidance for road mitigation schemes and their environmental design in the Yellowstone-to-Yukon ecoregion and beyond.

4) International Public-Private Partnership

A partnership was formed in February 2005, between a consortium of international interests, academic, governmental and non-governmental, committed to seeing a sweeping change in how roads intrude upon natural landscapes and stimulate institutional change towards more ecologically-sensitive mitigation concepts. This is truly an exciting and prosperous venture into what is rapidly emerging to be the most important land and wildlife conservation challenges of this new century. In April 2005, Parks Canada signed a Memorandum of Understanding with the Western Transportation Institute-Montana State University (WTI-MSU). The unique partnership is made up of four, leading North American conservation-based foundations and science agencies: Parks Canada, the Western Transportation Institute (Montana State University – Bozeman), the Woodcock, Henry P Kendall, and Wilburforce Foundations.

I. NARRATIVE

INTRODUCTION

Major transportation corridors and road networks are of greatest concern and perhaps the most acute obstruction to conserving animal populations in the Yellowstone-to-Yukon ecoregion. In the last 10 years, there has been a surge of interest in the ecological effects of roads on landscape ecology and devising means of reducing the impacts to wildlife populations. The design and performance of wildlife crossings as mitigation measures has received considerable attention.

The goal of this project is to continue research, monitoring and transfer of science-based information that will result in a range of applications useful to transportation planning, practice and policy in areas where road networks and landscape conservation concerns collide.

OBJECTIVES

Our project will continue research, monitoring and transfer of science-based information that will result in a range of applications that have immediate application to transportation planning, practice and policy. There are four main objectives:

1) Determine the efficacy of a DNA-based hair sampling technique by measuring a hair-capture success rate and make progress in ensuing applications of technique to assess the conservation value of wildlife crossings.
2) Continue long-term research of wildlife crossings and developing science-based guidelines for transportation departments, land management agencies, and conservation community.
3) Ensure technology transfer by disseminating research findings in scientific journals, international meetings, and technical courses.
4) Secure a Memorandum of Agreement between Parks Canada and the Western Transportation Institute-Montana State University (WTI-MSU) to share costs and commit to a continued highway mitigation research program between 2005 and 2007.

PROGRESS

1) DNA pilot project

Currently there is scepticism among some transportation and land management agencies regarding how well wildlife crossings perform or their cost-benefit in transportation projects. Although intuitively these conservation measures should enhance population viability, to date there are no other studies that actually address their population level effects. Consistent empirical evidence regarding population level effects of wildlife crossings is needed to support their continued and growing implementation by transportation and resource management agencies.

If each time an animal used an wildlife crossing, it wrote their name, told who their relatives were, and how far they were from home - our problems would be solved. Since they are unable to do so, in 2004, with funding from the Woodcock Foundation, we began testing a technique where animals leave a bit of DNA (hair) when passing through an underpass.

This pilot study has been testing and developing a simple, non-invasive, cost-effective method to identify individual animals using wildlife crossings, thus providing a direct measure of gene flow across roads. Once the method is developed, it will be implemented in a broader, field study to obtain DNA samples of animals using crossings (the technique piloted) in addition to sampling the larger population bisected by a highway such as the Trans-Canada in Banff (using other established methods). Determining the number of individuals using the crossings, their sex and genetic ancestry, will be key information needed to assess the conservation value of crossings at the population level. The method will provide critical information on breeding movements, dispersal and levels of genetic interchange.

The aim of our pilot study was to test the efficacy of the DNA/hair sampling system to obtain hairs of passing large carnivores, primarily bears, when using the underpasses. We did this by (1) quantifying the number of carnivore approaches, (2) the behaviour of carnivores entering the underpass (avoidance/turnaround or pass-through), and (3) if they passed through, how successful were we at snagging their hair. The DNA/hair sampling system was set up at two underpasses, as in 2004. Our 2005 field season was conducted from late-April to mid-August (3 ½ months of monitoring). We checked the two underpasses daily and collected information on animal use of the underpass and DNA/hair sampling success from racked trackpads, videocameras and the hair-sampling system.

Results –

DNA/hair capture efficacy - There were a total of 56 approaches to the two underpasses by carnivores; 43 approaches were by bear species (24 black bears, 19 grizzly bears; **Appendix 1,Table 1**). Bears turned around or avoided the underpasses less than 10% of the time; 2 of 24 black bears and 1 of 19 grizzly bears. The hair capture success rate was high for both bear species, greater than 90% of the time bears passed through the underpasses they left hair. For grizzly bears, 94% of the time they used they underpasses we were able to capture hair. Cougars can easily jump over the DNA/hair sampling system, but in 2005 they used the underpasses five times. Three out of five times (60%) cougars used the underpasses we obtained hair samples. Single wolves avoided the underpasses the first four times approaching; however, each time the lone wolf successively came closer to the DNA/hair sampling system. On the fifth and subsequent approaches the wolf passed through the hair-sampling system with little or no hesitation. We obtained hair samples from the wolf during 3 of 5 (60%) times they used the underpasses.

DNA profiling of individuals using crossings during pilot study – Although this was not a primary objective of our pilot study, we were interested in learning two things about the DNA/hair-sampling technique: 1) How efficient was our method of sampling hairs with extractable DNA? (i.e., DNA extraction success rate); and 2) How many individuals used the two underpasses and how many were males and females? We only report on DNA data collected from 2005 because in 2004 we tested several DNA/hair sampling systems (**Appendix 1, Tables 2A & 2B**). The system used in 2005 will be used in a future study implementing the piloted method by measuring gene flow of grizzly and black bears using wildlife crossings and determining levels of connectivity needed to sustain populations (see below).

We sent a total of 56 hair samples from 2005 to the Wildlife Genetics International lab in Nelson, British Columbia for identification of species, individuals, and determination of sex of the

individuals. Thirty-six of the 56 (64%) samples were from bears; 20 samples were presumed to be from grizzly bears, 16 from black bears (**Appendix 1, Table 2A**). We also sent 3 hair samples from cougars, 3 from wolves, and 14 "unknowns". Some of the 'unknown' samples proved to be from carnivores. From this point on, we will limit our summary to the bear species because that was the primary focus of the pilot study and our future research.

The hair samples from bears had a high rate of success for DNA extraction as useable DNA could be obtained from nearly all of the samples (17 of 20 for grizzly bears; 9 of 12 black bear samples). For both bear species, 81% of the samples had sufficient DNA to allow genetic profiling.

To determine the actual number of individuals using the two underpasses the sex of each individual we obtained a hair sample had to be determined (**Appendix 1, Table 2B**). DNA/hair samples were obtained from 7 male bears (4 grizzly, 3 black) using the two underpasses, while 19 samples came from female bears (13 grizzly, 6 black). More than one sample could come from the same individual. For example, the same bear crossing on different days or us collecting two hair samples from the same bears passing one time. A total of 9 different bears used the two underpasses in 2005, 5 different grizzly bears (3 females, 2 males) and 4 black bears (2 females, 2 males).

Conclusions – The results we present are undoubtedly extremely encouraging. The DNA/hair-sampling system we developed during the 2-year pilot study has met all of our performance goals and criteria. This was clearly demonstrated by (1) the high number of bears approaching the underpasses, (2) the high number of bears actually using the underpasses and leaving DNA/hair samples, (3) the high rate of DNA extraction from the hair samples, (4) the number of actual individuals using the two underpasses, and (5) the number of female and male bears using the underpasses. It is important too remember that this sample was obtained from only 2 of 24 wildlife crossings on the TCH during a 3 ½ month period.

The system has clearly shown to be a powerful, non-invasive technique that is capable of providing critical information regarding genetic interchange facilitated by crossings, without ever having to capture or see an animal. We look forward to advancing our knowledge of methods and research into the conservation value of crossings by measuring genetic and demographic connectivity.

Post-DNA profiling pilot study – The above results demonstrate that we have developed an effective DNA/hair sampling system for bears. A 3-year PhD project is being initiated with Montana State University conservation genetics professor Dr S Kalinowski and will begin in spring 2006. Results from our 2-year pilot study were presented at the 2005 International Conference on Ecology and Transportation (see below) and a publication will appear in the conference proceedings. Further, a manuscript is in preparation describing method for publication in a peer-reviewed scientific journal.

Video material – More than 6 hours of videofootage has been compiled during the study, much of which is high-quality. Our videofootage has wide appeal and application; it has already been used by CBC Television News, Canadian Parks and Wilderness Society (CPAWS) video "Highways & Wildlife", Alberta Science Foundation "Science-in-a-Crate" Grade 9 curriculum,

and Parks Canada "Research Updates" public forum. Videofootage also will be part of a Whyte Museum of the Canadian Rockies exhibition on wildlife crossings planned May 2006 (see below).

2) Long-term monitoring and data collection

We are continuing to monitor the 24 wildlife crossings in Banff National Park. In addition to the regular movement of carnivores and ungulates using the crossings, we have obtained photographs of a rare species in Banff National Park, a red fox, using the Wolverine Overpass. The long-term data will be used in a time-series analysis in 2006 looking at wildlife response to crossings and their attributes during a decade (1996-2006) of monitoring. This analysis will provide greater refinement and detail to guidelines we have developed to date from the Banff research.

3) Dissemination & development of science-based information

Publications – Scientific/Technical

6 publications from our Banff research have appeared or will be in international, peer-reviewed scientific journals in 2005. Two of the publications are chapter in books being published by major international publishing companies (Cambridge University & Springer). Two additional publications were non-peer reviewed.

Peer review

Clevenger, A.P. 2005. Conservation value of wildlife crossings: measures of performance and research directions. *GAIA 14 :124129*. (www.oekom.de/gaia).

Clevenger, A.P. & N. Waltho. 2005. Performance indices to identify attributes of highway crossing structures facilitating movement of large mammals. *Biological Conservation 121:453-464.*

Clevenger, A.P. & J. Wierzchowski. In press. Maintaining and restoring connectivity in landscapes fragmented by roads. In *Maintaining Connections for Nature* (Eds. K. Crooks, M. Sanjayan). Cambridge University Press.

Clevenger, A.P & others, multi-authored report. In press. *Effects of Highways on Natural Communities and Ecosystems*. National Research Council committee publication, National Academies Press, Washington, DC.

Hansen, M. & A.P. Clevenger. 2005. The influence of disturbance and habitat on the frequency of non-native plant species along transportation corridors. *Biological Conservation 125:249-259.*

Huijser, M.P. & A.P. Clevenger. In press. Habitat and corridor function of rights-of-ways. In: *The ecology of transportation: managing mobility for the environment*. J. Davenport & J.L. Davenport (eds). Springer, London, UK.

Non-peer review

Clevenger, A.P. In press. *Science-based approach to adaptive management of the Trans-Canada Highway corridor - Canadian Rocky Mountain parks*. 2005 Proceedings of the International Conference on Ecology and Transportation, San Diego, CA.

Clevenger, A.P. 2005. *Population benefits of wildlife crossings using DNA methods*. Transportation Research Board ADC10 Newsletter (August) – Environmental Analysis in Transportation. Pages 6-7.

Media attention (press, web-based, television, radio)

Press

Rocky Mountain Outlook (Canmore/Banff)
Alberta Views – "Life and Death on the Banff Highway" (B Gadd)
Rocky Mountain News – "Noah's arch envisioned for Vail Pass"

Durango Herald - "Proposed wildlife overpass near Vail a first"
Helena Independent Record – "Experts seek roadkill reversal'
Christian Science Monitor – (appearing week of 31 October 2005)

Web-based publications

Stateline.org – "Why did the moose cross the road?"
MSNBC.com – "More wildlife getting help across the highway"

Television

Canadian Broadcasting Corporation (CBC) Television – "Evening news" Calgary
Tokyo Broadcasting Corporation – "Amazing Animals"

Radio

Radio-Canada (CBC-French) - "Morning show" interview.

Presentations – Scientific/Technical

Rockies Wildlife Crossing Field Course. "*The Enigma of Wildlife Crossings*: *Where to place them and do they work?*", Payson, AZ, April 11-13, 2005.

2005 International Conference on Ecology and Transportation. "*Science-based approach to adaptive management of the Trans-Canada Highway corridor - Canadian Rocky Mountain parks"*. San Diego, CA, 28 Aug – 2 Sept, 2005.

Seminário Infraestructuras Lineares e Biodiversidade. "Long-term monitoring and DNA -based approaches for restoring landscape connectivity across transportation corridors in the Canadian Rocky Mountains". Universidade de Evora, Portugal, 13-14 Oct. 2005.

Yellowstone-to-Yukon Annual Network Gathering, Jackson Hole, WY, 13-14 Oct, 2005 (invited to speak about Banff research but conflicted with above. WTI colleague filled in)

Presentations – Public

Parks Canada, Research Updates Speaker Series – Banff, Alberta

International Union for Conservation of Nature (IUCN) World Commission on Protected Areas – Presentation of Banff research and visit to wildlife overpass.

Trustees of Sonoran & Chinook Institutes – Presentation of Banff research and visit wildlife overpass

Education – Academic & Technology Transfer

PhD research project – Collaboration with Montana State University Dept of Ecology Implementing DNA-based technique to measure population-level benefits of crossings (start date: spring 2006).

National Science & Engineering Research Council (Canada) postdoctoral fellowship – 2-year research position has been advertised. Project will model population-level benefits using Banff grizzly bear data and will compliment PhD research above. Start: spring 2006.

California Department of Transportation - Dr Clevenger has begun a collaborative study California researching the conservation value of wildlife crossings for federally endangered species San Joaquin kit fox using the piloted DNA-based sampling method in Banff.

Canadian Institute of Transportation Engineers, Annual Meeting 14-17 May 2006, Banff, Alberta. Training seminar **"**Guidelines for designing, monitoring and evaluating performance of wildlife crossings".

University of Manitoba, Conservation Biology Department. Lecture and field class showing Banff research and mitigation (June 2005).

Education – Public Awareness and Information

Parks Canada – (1) Parks Canada News Release, Innovative Partnership to Benefit Research and Monitoring of Wildlife Crossings in Banff (see Appendix 2); **(2) Lake Louise Campground**

Theatre, "*Lake Louise is expecting twins*!" (summer-long public interpretation programme); **(3) Park Radio** – Interview w Clevenger regarding Banff DNA pilot study; **(4) Parks Canada Website**, "*Time for Nature*" (general audience; conservation issue tied to national parks; reports DNA-pilot study); **(5) Poster** – Publication of Parks Canada-produced poster informing of benefits of wildlife crossings and international public-private partnership created.

Thomson-Nelson Publising, Scarborough, Onatario, Canada – Report on Banff mitigation and research for grade 4 textbook.

Alberta Science Foundation, "Science-in-a-Crate" – Grade 9 curriculum on biodiversity; examples of real science solving problems; highlights grizzly bears, habitat connectivity and DNA/hair-sampling project.

Arctos & Bird's Bison Courtyard (Bear Street), Window display with panel/poster informing of benefits of wildlife crossings and international public-private partnership created.

Whyte Museum of the Canadian Rockies – special exhibit on wildlife crossings and research has been granted - will begin May 2006.

American Museum of Natural History, New York – upcoming Yellowstone-to-Yukon exhibit will feature photographs of wildlife use of Banff crossings.

4) International Public-Private Partnership

Perhaps the most important of the four objectives was to secure a Memorandum of Agreement (MOA) between Parks Canada and the partnering institutions and foundations to share costs and commit to a continued highway mitigation research program. On April 8, 2005, Parks Canada signed a Memorandum of Understanding (Appendix 3) with the Western Transportation Institute-Montana State University (WTI-MSU) whereby the former commits a financial contribution of $CD 60,000 to the project during the fiscal year 2005-06 (ending 31 March 2006), while the latter contributes $US 40,000 during the same period.

One day prior to the signing of the MOA on April 7, 2005, the Board of Directors of the Wilburforce Foundation approved a $US 10,000 grant WTI-MSU submitted to support of Dr Clevenger's research project titled, "DNA Profiling at Wildlife Crossings."On June 17, 2005, the Trustees of the Henry P Kendall Foundation approved a grant of $US 45,000 to the WTI-MSU to support the Banff research aimed at improving the understanding of the biologic and genetic efficacy of highway wildlife crossings.

2006 Woodcock Proposal

We will be submitting a 2006 grant proposal to the Woodcock Foundation. The request will be for continuing the international pubic-private partnership that has been formed that will allow for the continuation of long-term monitoring and DNA-based approaches for restoring landscape connectivity across transportation corridors.

PROJECT PARTNERS

Parks Canada, Banff National Park, *Banff, Alberta*
Parks Canada, Ecological Integrity Branch, *Ottawa, Ontario*
Western Transportation Institute, Montana State University, *Bozeman, Montana*
Woodcock Foundation, *New York, New York*
Henry P. Kendall Foundation, *Boston, Massachusetts*
Wilburforce Foundation, *Seattle, Washington*
Humane Society of the United States, *Washington, DC*

II. FINANCIAL

Financial sheet

Expense Categories	Original Budget	Actual Expenditures
Salaries	14,140.33	18,035.46
Benefits	4,093.00	5,364.88
Travel		1,823.47
Communication	100.00	0.00
Contr. Svcs.	0.00	0.00
Supplies		6,669.52
Subcontracts	15,000.00	1,440.00
Total Direct costs	33,333.33	33,333.33
Indirect costs @5%	1,666.67	1,666.67
TOTAL	**35,000.00**	**35,000.00**

III. APPENDICES

APPENDIX 1.

TABLE 1

Summary data for DNA profiling pilot study in Banff National Park, Alberta, Canada. Summarized is (1) the response of carnivores to DNA/hair sampling system located at two underpasses, and (2) the hair-capture success rate from carnivores using the underpasses. The study was conducted from May to mid-August 2005 (3 ½ months) and underpasses were checked on a daily basis.

	(1) BEHAVIOUR			**(2) HAIR CAPTURE SUCCESS**	
	Number of approaches	**Number of turnarounds* (%)**		**Pass/No hair (%)**	**Pass/Hair (%)**
Black bear	24	2 (8)		4 (18)**	18 (82)***
Grizzly bear	19	1 (5)		1 (5)	17 (94)
Subtotal	**43**	**3 (7)**		**5 (12)**	**35 (88)**
Wolf	9	4 (44)		2 (40)	3 (60)
Cougar	5	0 (0)		2 (40)	3 (60)
TOTAL	**56**	**7 (12)**		**9 (18)**	**41 (83)**

* Turnarounds are when animals avoid hair-sampling system by not passing through underpass.
** 9% not including cubs.
*** 91% not including cubs.

TABLE 2A

Summary data for DNA profiling pilot study in Banff National Park, Alberta, Canada.
Hair samples were collected from animal use of two underpasses between May and August 2005. Samples first identified to "species". Once "species" was confirmed, the 'individual" was identified. Some samples were repeats of same individual.

	Hair samples	Identified to species	Comments	Individual Identification
Grizzly bear (grbear)	20	20	1 failed; 1 from "wolf"	17 of 20 samples (85%)
Black bear (blbear)	16	12	4 failed; 1 w/o root; 1 from "unknown"	9 of 12 samples (75%)
SUBTOTAL	36	32		26 of 32 samples (81%)
Cougar	3	2	1 failed	2 of 3 (66%)
Wolf	3	0	1 failed; 1 was "grbear"; 1 was "hare"	1 of 3 (33%)
Unknown	14	8	1 blbear; 1 wolf; 5 elk; 1 coyote; 5 failed; 1 no root	8 of 14 (57%)
TOTAL	**56**	**42**		

TABLE 2B

DNA profiling pilot study in Banff National Park, Alberta, Canada 2005.
Sex identification of "individual" samples from Table 2A, and the determination of actual number of individual males and females detected using the two underpasses by piloted method from May to August 2005.

	N samples Male	N samples Female	Individual Males	Individual Females
Grizzly bear (grbear)	4	13	**2**	**3**
Black bear (blbear)	3	6	**2**	**2**
SUBTOTAL	7	19	**4**	**5**
Cougar	2		1	
Wolf	1		1	
TOTAL	**10**	**19**	**6**	**5**

APPENDIX 2.

Parks Canada Press Release

APPENDIX 3.

Parks Canada Agency & Western Transportation Institute
"Memorandum of Agreement"