MAKING SCIENCE, MAKING CHANGE:

CELEBRATING FIVE YEARS OF RESEARCH AND COLLABORATION IN THE YELLOWSTONE TO YUKON REGION

1999-2003

May 7-9, 2003
University of Calgary

SYMPOSIUM COMPENDIUM

Yellowstone to Yukon Conservation Initiative

Photo: Tom Crum

Welcome!

In May 2003, the Yellowstone to Yukon Conservation Initiative (Y2Y) and the Wilburforce Foundation celebrated a shared milestone: Five successful years of supporting scientific research and science-based conservation through the Yellowstone to Yukon Conservation Science Grants Program. Program grantees and other friends and colleagues from the region's academic, non-governmental and governmental communities gathered together with our organizations at the University of Calgary to learn about and acknowledge one another's work. Plenaries, poster sessions, fishbowl discussions and keynote speakers encouraged us to stretch our collective imagination about what's possible within scientific inquiry and discovery, and to consider the necessary – but not exclusive – role that science plays in delivering conservation in the Yellowstone to Yukon region.

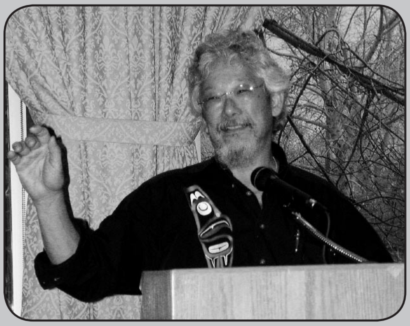
Symposium plenary sessions showcased the exciting new knowledge emerging from the grantees' research alongside examples of its successful translation into conservation-friendly policies and practices. Discussion sessions explored the complexity of working in science-advocacy partnerships and the value of mentoring as a critical strategy for cultivating the next generation of conservation professionals.

This compendium brings together in one place summaries and key lessons from these sessions and, accordingly, insights arising from the past five years of the Yellowstone to Yukon Conservation Science Grants program. Y2Y and Wilburforce have harvested these lessons both to inform and strengthen our future grantmaking and to provide a resource for our colleagues in science and conservation.

We would like to thank the Faculty of Environmental Design, University of Calgary for co-sponsoring the event and everyone on the conference planning team. We hope that the ideas and energy represented on the following pages inspire you, as they do us, to learn more and renew commitment to work together to achieve the Y2Y vision of a life-sustaining web of protected wildlife cores and connecting wildlife corridors designated for the Yellowstone to Yukon region.

For All Things Wild,

Marcy Mahr & Gary Tabor
Yellowstone to Yukon Conservation Initiative & Wilburforce Foundation



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Y2Y & THE YELLOWSTONE TO YUKON CONSERVATION SCIENCE GRANTS: AN OVERVIEW

WHAT AND WHO IS Y2Y?

Yellowstone to Yukon (Y2Y) is:

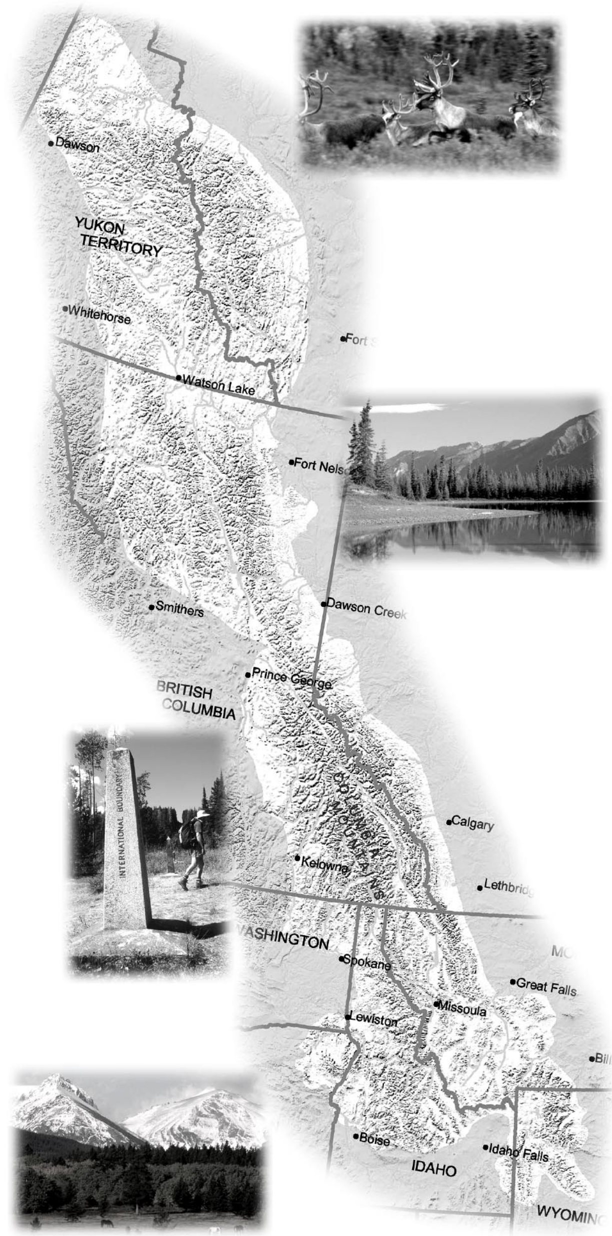
- a **landscape**
- a **vision**
- an **international network** and
- an **organization** - the Yellowstone to Yukon Conservation Initiative

THE Y2Y LANDSCAPE

The Yellowstone to Yukon ecoregion is home to some of the most spectacular wilderness in the world, a rich diversity of wild habitats and creatures, and a wide variety of human communities and cultures.

Y2Y stretches 3200 kilometres (2000 miles) along the Rocky Mountains from the Wind River Range of west-central Wyoming to the Peel River watershed in the northern Yukon. The width of this region varies from 200 to 800 km (125-500 miles) according to ecological boundaries along the eastern foothills and the western inland-coastal watersheds.

Zooming in on this vast region – 1.3 million km^2 in all – one finds a patchwork of shrub steppe grasslands and foothill parklands, stands of old Ponderosa pine and ancient inland rainforests of western red cedars, aspen groves skirting montane bench lands, and alpine meadows and tundra that dot even the harshest areas with life. Hundreds of rivers whose headwaters originate in the high mountains of the Continental Divide, and whose waters will ultimately flow into three different oceans, stitch their way across this patchwork nourishing and connecting human and non-human communities alike.



THE Y2Y VISION FOR THE FUTURE OF THE WILD HEART OF NORTH AMERICA:

We envision a day…

> *"…when a life-sustaining web of protected wildlife cores and connecting wildlife corridors has been defined and designated for the Yellowstone to Yukon region. A day…when that life-sustaining web is embraced as a source of pride by those who live within and visit it, and is acknowledged as a living testimony to a society wise enough to recognize the need for such a web, altruistic enough to create it, and prudent enough to maintain it."*

THE Y2Y NETWORK AND ORGANIZATION

The Yellowstone to Yukon Conservation Initiative was founded in the early 1990s by a group of conservation advocates and scientists. The Initiative aspires to bridge science and stewardship by encouraging researchers, conservationists and citizens of the Y2Y region to work together toward our common objective of:

> *"…maintaining in perpetuity viable, well distributed populations of native species and the ecological processes upon which they depend in the face of increasing human population, habitat alteration, changing land-use and climate change."*

The hallmarks of the Yellowstone to Yukon Conservation Initiative are:

- Interdisciplinary **research groups** which advise and contribute to our science program and conservation area design.
- Numerous trans-boundary **partnerships and workshops** that facilitate science and conservation efforts across the US-Canada border.
- **Media tours** designed to promote the Y2Y vision and tell the story of conservation challenges and successes.
- An international **listserv** connecting Network participants and others across the Y2Y region for exchanging information, ideas and other resources.
- **Capacity building workshops** that strengthen the effectiveness of Network groups' work in coalitions, negotiations, communications and fundraising.
- **Y2Y Conservation Science Grants program**, the theme of which is ecological connectivity that provides a strategic focus for testing approaches to studying diverse species and geographies within the Y2Y region, with the goals of bringing appropriate conservation practices to bear in specific landscapes and, at the same time, accelerating our collective education in ecology.

Today, more than 500 conservation-minded organizations and individuals have officially endorsed the Y2Y Vision by participating in the Y2Y Network. These include non-profit organizations, universities, private institutes, foundations, activists, recreationists, business owners, land trusts and others from many walks of life. All told, nearly one million people who are working together to maintain and restore the unique natural heritage of the Yellowstone to Yukon region.

We support the
Yellowstone to Yukon
Conservation Initiative

THINKING BIG

With its enormous and varied physical landscape, ambitious vision and diverse human network, Y2Y serves as an international case study for large-scale research and conservation strategies. Y2Y compels each of us as scientists, conservation advocates, land managers, politicians or citizens to think bigger than we are accustomed to, and to ask ourselves how our own particular 'patch' fits into the larger quilt that is Yellowstone to Yukon.

IF WE BUILD IT, WILL THEY COME?

The Yellowstone to Yukon Conservation Science Grants program was initiated by the Wilburforce Foundation and the Yellowstone to Yukon Conservation Initiative in 1999. Anchored by the following beliefs:

- Maintenance and restoration of connectivity is the ecological key to achieving the Y2Y vision of conserving native biodiversity, and
- Conservation advocacy in the Y2Y region is most effective and enduring when informed by scientific understanding, Y2Y and Wilburforce sought to create a grants program that would encourage both scientific inquiry into ecological connectivity and promote conservation advocacy that would make effective use of the knowledge resulting from this inquiry.

To this end, the Y2Y Conservation Science Grants program pioneered an approach of funding research partnerships between scientists and conservation organizations. Prospective partners needed to demonstrate not only the merit of the research being proposed, but also its relevance to the work of the conservation organization and how, together, they would contribute to policies and practices that benefit wildlife and critical habitats.

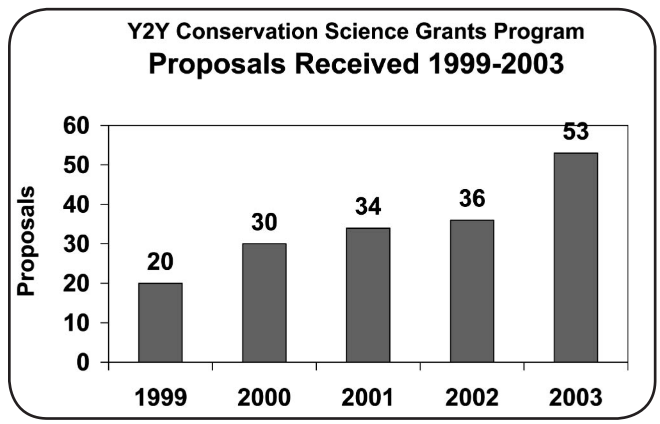
The specific objectives of the program are to:

- Enhance the scientific knowledge base of conservation activism in the Yellowstone to Yukon ecoregion.
- Establish bridges between the conservation non-profit community and the region's academic and research institutions.
- Foster support for young scientists to participate actively in the region's conservation community.

YES, THEY WILL COME

In the five years that have passed since the first Request for Proposals was circulated, the program has clearly caught on and made its mark on science and conservation in the Y2Y region. The number and diversity of applicants and applications each year has increased steadily, and a total of 46 different projects have been funded. They address species and systems situated throughout the Y2Y region:

- from one Y to the other and many points between,
- from the western slopes east across the continental divide to prairie foothills, and
- in alpine, sub-alpine and montane ecozones.



The Y2Y Conservation Grantmaking has attracted a growing number of researchers who want to see the results of their research moved out into the world of conservation, and organizations who are looking to science to help inform their conservation priorities and shape their conservation programs.

Through the science grants program, the Y2Y conservation community has:

- **New information and tools for strengthening the scientific justification for landscape connectivity.** On-going connectivity studies of grizzly bears, cougars, bull trout and trumpeter swans, and new studies of woodland caribou and sage grouse are helping conservation organizations throughout the region – including the Yellowstone to Yukon Conservation Initiative itself – to accomplish a key conservation objective: *To demonstrate that connectivity achieves measurable progress in wildlife conservation and recovery.* This offers a much stronger basis for advocating policies that protect wide-ranging species as an important constituent of biodiversity in the Rocky Mountains, and for preventing further loss of habitat for these species.

- **Firsthand experience working in science-advocacy partnerships.** Increasingly, conservation organizations are using scientists and their research as resources in conservation programming. Scientists, in turn, are exploring various avenues they can take to inform and service conservation issues and efforts in the region. With science-advocacy collaboration a prerequisite in the granting program, we are able to consider the dozens of partnerships that have been funded in order to appraise how successful partnerships work.

> *"…Entirely new ways of doing science and contributing to society are evolving and… what we are seeing at this conference demonstrates a particularly successful approach."*
>
> *– Tim Clark 2003*

- **An emerging group of young, conservation-minded scientists.** Thirty per cent of the projects supported by Y2Y Conservation Science Grants have been led by graduate student researchers. Through the experience of completing their masters or doctoral research in partnership with conservation organizations (and others, such as land management agencies or industry), these 14 individuals have not only received training in their chosen disciplines but also have been exposed to the "real world" of conservation in ways that compel them to explore and begin defining their personal roles as scientists in society.

Between 1999 and 2003, Y2Y Conservation Science Grants have supported:

***46** different projects, **54** principle researchers,*
***32** non-governmental organizations,*
***10** universities and **14** graduate students, through*
***63** grants totaling more than **US $1million**.*

SYMPOSIUM AGENDA

UNIVERSITY OF CALGARY
MAY 7TH-9TH, 2003

MAY 7TH

Evening

5:00 - 9:00 pm	**Registration**	Main Foyer, Science Theatres
	Poster Set-Up for Grantees	The Pit, Science Theatres
7:00 - 9:00 pm	**Reception** - Hosted by the Faculty of Environmental Design, University of Calgary	EVDS Gallery, Prof. Faculties Bld.

MAY 8TH

Morning

7:45 am	**Latecomers Registration**	Main Foyer, Science Theatres
8:00 am	**Continental Breakfast available**	Main Foyer, Science Theatres
8:30 am	**Welcome & Introduction**	Science Theatres, Room 140
9:00 am	**Plenary Session I** *Making Science in Y2Y: Research Highlights* Plenary Remarks: Dr. Michael Reed, Tufts University	Science Theatres, Room 140
9:15 am	**Plenary Presentations:** *Bridging Scales, Bridging to Conservation Practice: Y2Y Grizzly Bear Science* Dr. David Mattson, USGS *Mapping Hotspots of Avian Biodiversity across Landscapes* Kingsford Jones, Montana State University	
10:15 am	**Questions**	
10:30 am	**Break**	
10:45 am	**Plenary Presentations continue:** *Connectivity among Y2Y Cougar Populations: Lessons from a Cougar Virus* Roman Biek, University of Montana *DNA Reveals Demographic Fragmentation of Grizzly Bears in the Y2Y Corridor: Is a 'Metapopulation' Possible?* Dr. Mike Proctor, University of Calgary	Science Theatres, Room 140

11:45 pm	**Questions**	
12:15 pm	**Lunch & Optional Discussion Session** *Theme: Mentoring as a Critical Leadership Strategy* Mike Quinn, University of Calgary Ted Smith, Kendall Foundation	Blue Room, Dining Centre

Afternoon

1:30 pm	**Guest Speaker:** *Corridors, 'Fragmentation Experiments,' and Biodiversity – an Australian Perspective* Dr. David Lindenmayer, Associate-Professor, Centre for Resource & Environmental Studies, The Australian National University	Blue Room, Dining Centre
2:30 pm	**Fishbowl Discussion I** *Joy, Complexity, and Rigor: Making Science*	
	Introduction	Blue Room, Dining Centre
	Discussions	125,126, 128 Science Theatres
3:55 pm	**Break**	

Evening:

5:30 pm	**Poster Session & Social** **Host Bar**	The Pit, Science Theatres
7:00 pm	**Banquet Dinner**	Blue Room, Dining Centre
	Keynote Address, Dr. David Suzuki: *Setting the Real Bottom Line in the 21st Century*	Blue Room, Dining Centre

MAY 9TH

Morning

8:00 am	**Continental Breakfast available**	Main Foyer, Science Theatres
8:30 am	**Plenary Session II** *Making Change in Y2Y: From Science to Conservation Action* **Plenary Remarks:** Dr. Tim Clark, Yale University, Northern Rockies Conservation Cooperative	Science Theatres, Room 140
8:45 am	**Plenary Presentations:** *From Afterthought to Planning Principle: Mapping the Route towards Connectivity in Banff National Park*	

Mike McIvor, Bow Valley Naturalists; Tony Clevenger, University of Calgary; Danah Duke, Miistakis Institute for the Rockies

Science and Conservation Planning across Scales in the Crowsnest Pass Region
Clayton Apps, Wildlife Conservation Society; Larry Simpson, Nature Conservancy of Canada; Cheryl Chetkiewicz, University of Alberta

The Role of Partnerships for Conserving Grizzly Bears on Private Lands: A Perspective from the Field
Seth Wilson, University of Montana

10:15 am	**Questions**	
10:45 am	**Break**	
11:00 am	**Fishbowl Discussion II** *Passion, Policy, and Practice: Making Change*	
	Introduction	Science Theatres 140
	Discussions	125,126, 128 Science Theatres

Afternoon

12:15 pm	**Break**	
12:30 pm	**Lunch**	AB Room West, Dining Centre
	Closing Address: Dr. Carolyn Callaghan, Central Rockies Wolf Project	
	Closing Comments: Y2Y Conservation Initiative and the Wilburforce Foundation	

Dr. Carolyn Callaghan giving the Closing Address:

C. MAKING SCIENCE IN Y2Y

1. CONNECTIVITY IS THE KEY

> *"We will not succeed in conserving biodiversity in Y2Y unless we are successful in maintaining connected wildlife populations and the habitats on which they depend."*
>
> *—"Making Science" Session Chair Dr. Michael Reed*

MAKING SCIENCE IN Y2Y: RESEARCH HIGHLIGHTS – PLENARY SESSION

Remarks: **Dr. Micheal Reed, Tufts University**

Presentations:

Bridging Scales, Bridging to Conservation Practice: Y2Y Grizzly Bear Science
Dr. David Mattson, USGS

Mapping Hotspots of Avian Biodiversity across Landscapes
Kingsford Jones, Montana State University

Connectivity among Y2Y Cougar Populations: Lessons from a Cougar Virus
Roman Biek, University of Montana

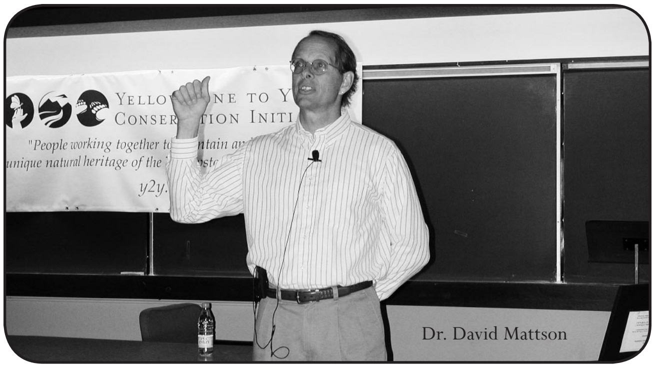
DNA Reveals Demographic Fragmentation of Grizzly Bears in the Y2Y Corridor: Is a 'Metapopulation' Possible?
Dr. Mike Proctor, University of Calgary

The Y2Y Vision is one of conserving native biodiversity across a vast, continental-scale ecoregion. Ecological connectivity lies at the heart of this vision.

In his opening remarks, "Making Science" Plenary Session Chair Dr. Michael Reed emphasized the overarching importance of landscape and population connectivity to the long-term viability of wildlife populations in the Y2Y region. Without connectivity, key population processes of species dispersal, colonization and gene flow can be disrupted or disabled, and affected populations eventually lose their ability to persist in the face of the threats posed by an increasing human population, habitat alteration, changing land-use and climate change.

Moving from an acknowledgement of the importance of connectivity at a fundamental level toward understanding the specific biological mechanisms that facilitate it or the factors that enable or disable it for a variety of species across the Y2Y landscape presents an enormous scientific challenge. Dr. Reed highlighted several major components of this challenge:

- **Identifying the appropriate spatial and temporal scales at which to investigate a particular connectivity question** given that ecological processes can play out across areas of few square metres or over thousands of square kilometres, in periods of a few years or many centuries.



Dr. David Mattson

- **Identifying focal species** – Identifying focal species that will reveal the most useful information about the requirements of the broadest possible number of additional species, given that it is not possible to survey all species.
- **Identifying population core areas and ways to maintain or restore connectivity between them as a means to ensure viable populations.**
- **Developing and applying cost-effective and accurate methods to measure population connectivity,** especially for wide-ranging species occurring at low densities in the Y2Y region.
- Using the above knowledge to **create effective conservation tools.**

Making Science plenary presentations provided examples of how Y2Y Conservation Science grantees have successfully addressed these issues either in the course of conducting their research or as its central aim. Dr. David Mattson walked participants through an example of how Y2Y-scale information about grizzly bears can be bridged to finer scales to add value to regional or local conservation efforts to protect grizzly bears. Kingsford Jones tackled another facet of the question of spatial scale in describing a pioneering method for predicting broad, landscape patterns of avian species diversity that integrates local-scale, breeding bird survey data with continental-scale bird data derived from satellite imagery. Dr. Michael Proctor and Roman Biek described two very different, yet equally powerful, applications of genetic analysis for assessing the degree of connectivity among grizzly bear and cougar populations, respectively. Their research raises important questions about how well our conception of 'meta-populations' resonates with the on-the-ground reality of connectivity for grizzly bears versus cougar populations in the central portion of the Y2Y ecoregion. It also introduces the notion of understanding connectivity or fragmentation-different sides of the same ecological coin – as a process occurring over time and not simply as a static state of affairs.

The plenary presentations, together with the many posters on display at the science symposium, communicated to participants the diverse and innovative ways in which Y2Y Conservation Science grantees are addressing the scientific biodiversity challenge in Y2Y, and the exciting results that are emerging from their efforts. This work and their findings were captured in summary format and are presented on the pages that follow.

Kingsford Jones

2. Y2Y CONSERVATION SCIENCE GRANTS 1999-2002

PROJECT SUMMARIES

The Y2Y Conservation Science Grants Program plays an important role in identifying and prioritizing the actions that need to be taken to maintain or restore connectivity for a myriad of species and habitats. Program grantees have investigated:

- What connectivity looks like for a myriad of species whose movements take them across diverse landscapes.
- The ways in which population or habitat connectivity manifests itself as a process among different species and landscapes.
- Local threats to population or habitat connectivity and the mechanisms by which they work against connectivity.
- Methods with which connectivity can be most accurately and efficiently measured.
- The effectiveness of measures that have been taken to maintain or restore connectivity.

Through their efforts we now know that:

- Migratory Rocky Mountain Trumpeter Swans use a very narrow migration corridor often <50 miles wide.
- Male wolverines in the Greater Yellowstone Ecosystem can travel great distances within relatively short periods of time and can have enormous home ranges (upwards of 27,000 km^2).
- Existing highway mitigation structures along the US I-90 are likely not functioning effectively to enable movement of large and medium size mammals across the highway, but there are specific, minor adjustments which can be made that might help to improve the functionality of the structures for these species.
- Along British Columbia's Highway 3 there is no evidence female grizzlies cross the highway through the Purcell Mountains; whereas Highway 3A in the South Selkirk Mountains, a complete fracture of grizzly bear movement is possible limiting movement of both males and females.
- Cougar 'populations' in the central portion of Y2Y are most likely well-connected and their connectivity can be accurately measured through genetic analysis of a feline virus.

These examples hint at the breadth of new knowledge that has been generated by the grantees' research and is profiled in this section of the compendium. Read the project summaries that follow to learn more about this research and its relevance to conservation.

A complete listing of all projects funded by the program is included as Appendix A.

Note: The majority of research projects supported by the Y2Y Conservation Science Grants program from 1999-2002 are represented here. Projects are grouped according to species, taxa or other focal theme organized alphabetically by title within each of these groups.

For ease of reference, the projects are grouped under a corresponding icon found on each page header.

GRIZZLY BEARS

UNGULATES

CARNIVORES

ROADS & ROAD ECOLOGY

AVIAN

AND MORE...

AQUATICS

All summaries were contributed by and thus are attributed to the researchers themselves.

A STUDY OF GRIZZLY BEAR MOVEMENTS, CORRIDOR DESIGN ATTRIBUTES AND MANAGEMENT TO MINIMIZE GRIZZLY-HUMAN ENCOUNTERS IN A PROTECTED WILDLIFE CORRIDOR ACROSS THE CENTRAL ROCKIES, KAKWA PROVINCIAL PARK, BC

Principal Investigator: Wayne McCrory, McCrory Wildlife Services Ltd.

Partnering Organization: Valhalla Wilderness Society

1999-2001

Kakwa Provincial Park is a large (170,732 ha) recently protected class A Provincial Park in the Central Canadian Rockies. It protects a 50-km-long mountain pass system that crosses through Kakwa Lake and the rugged Continental Divide, an area surrounded by hanging glaciers and rugged mountain peaks > 4000 metres. The Kakwa Lake Wildlife Corridor is considered almost unique in North America in that it is one of the few major mountain passes that transects the Great Divide of the Rocky Mountains that has not been historically developed for public transportation, pipelines and power lines. The Kakwa Lake Wildlife Corridor thus provides a unique opportunity to not only carry out long-term baseline research on grizzly bear/wildlife travel routes (Part II), but to utilize this and other information to design a program to minimize grizzly bear-human conflicts within a protected corridor setting (Part I).

Part I, under the auspices of the management agency "BC Parks", involved a Geographic Information System (GIS) grizzly bear habitat map and a Bear Encounter Risk Model. This was used to set guidelines to minimize conflicts between park visitors and grizzly bears as well as to recommend that the Kakwa Lake Wildlife Corridor be given a high conservation priority in an on-going park management plan. Part II, under the auspices of the Valhalla Wilderness Society and umbrella of the Y2Y Science Program, involved research of specific grizzly bear travel pathways within the Kakwa Wildlife Corridor. Information generated from the studies is thus not only being used to help set proper management agency guidelines in the new park, but to also help identify biological map attributes to assist in the understanding, conceptual design and management of wildlife corridors elsewhere in the Y2Y Ecoregion.

Part I: A COMPUTER-ASSISTED GIS GRIZZLY BEAR ENCOUNTER RISK MODEL TO HELP MINIMIZE BEAR-HUMAN CONFLICTS IN A PROTECTED WILDLIFE MOVEMENT CORRIDOR ACROSS THE CONTINENTAL DIVIDE, KAKWA PROVINCIAL PARK, BC

Author: Wayne McCrory RPBio, with GIS mapping by Baden Cross and Steve Donelon.

Affiliates: BC Parks and the BC Habitat Conservation Trust Fund.

Purposes and Objectives:

In many parks and protected areas, infrastructure developments such as access roads, hiking trails, campsites, mountain lodges and other facilities have often been constructed with little or no regard the prime feeding habitats and travel routes of grizzly bears, wolves, caribou and other wildlife. In some instances, this has created conflicts between park visitors and grizzly bears that has led to serious human injuries or bears being killed or displaced by humans. The purpose of Part I was to adapt a computer-assisted GIS Bear Encounter Risk Model to rate the hazard of each hiking trail and campsite in the Kakwa Lake Corridor and to then make management recommendations to minimize conflicts.

This information has already been adopted into an on-going management plan for this new, large provincial park (Nash 2001).

Methods:

Methods were non-intrusive. The first step was to prepare a detailed GIS base map that showed all hiking trails, campsites, old roads, wildlife trails, streams and rivers, contour lines (relief) and other features. We then used a variety of techniques to measure seven variables used in the Bear Encounter Risk Model to rate the bear hazard. This included four bear parameters: bear habitats and potential, bear mark (rub) trees, bear travel, availability of ungulates to bears. Three trail design features were also used: visibility, noise factor and cover. Habitat was mapped by intensive ground-truthing. Bear travel was determined in the Part II corridor study. At the end of the study, a computer-assisted program was used to assign Eigen Vector weighted value to each of the seven variables. A previous expert bear panel determined these. The total score on a scale of one to ten determined the hazard rating. Then other factors were examined such as history of past encounters, degree of grizzly bear use, types of grizzly bears (adults, subadults, females with young) to determine a final hazard. A colour-coded map was then made showing the bear hazard of all park facilities. Recommendations were made to reduce the risk of bear encounters for people using each facility or cluster of facilities.

Principal results & conclusions:

We rated the bear hazard of 35 different hiking trails/ routes and 11 rustic campsites for the three bear seasons (green vegetation, berry and post-berry). This included 21 km of active access road and 89 km of hiking trails/abandoned roads and hiking routes. Many of the facilities were found to have a moderate risk for the public. However, data from the corridor study showed that the majority of grizzlies using hiking trails and access roads for travel were in the class least likely to be aggressive and harm people (single adults or single/pair subadults). Female grizzlies with young appeared to prefer higher elevation areas away from the majority of trails and campsites; although little data was gathered on their preferred habitats. We recommended that one campsite be relocated and, for some other trails, minor re-routing, warning signs and brushing be carried out. As well, the low recreation use in the Kakwa Corridor should be retained. Improving public access that would increase visitation significantly was forecast to eventually lead to high conflicts within the Kakwa Corridor. This would also displace some grizzly bear travel and feeding activities.

Relevance to Conservation in Y2Y Ecoregion:

The use of a standardized GIS Grizzly Bear Encounter Risk Model demonstrated the applicability of such an approach for other Y2Y areas where human recreational use mixes with grizzly bear travel and feeding habitats. However, ground-truthing for the Risk Model needs to be done by experienced bear biologists.

Part II: ASSESSMENT OF GRIZZLY BEAR MOVEMENTS WITHIN A PROTECTED WILDLIFE CORRIDOR ACROSS THE CONTINENTAL DIVIDE, KAKWA PROVINCIAL PARK, BC.

Authors: Wayne McCrory, Marty Williams, Lance Craighead, Paul Paquet, Baden Cross, April Craighead, and Troy Merrill.

Affiliates and Partner NGO's: The Valhalla Wilderness Society was the main sponsor, with some support from the Great Bear Foundation. The Craighead Environmental Research Institute (CERI) was an important affiliate. Besides the Wilburforce Foundation, the research was supported by the World Wildlife Fund Canada, Robert Schad Foundation and private donors. BC Parks provided research facilities.

Purposes and Objectives:

Wildlife corridors in mountainous areas are not difficult to roughly delineate using state-of-the art GIS design tools such as least-cost-path GIS modeling. However, since there has been little research on the pathways used by grizzly bears and other wildlife within large corridors we started a long-term research project in a large protected wildlife corridor, which has limited human development.

Methods:

Some methods were similar as for Part I. We determined individual grizzly bear (and black bear) movements through a system of strategically located remote self-activated cameras, hair collection, ground-tracking, tracking with trained dogs and direct observations. These methods were often combined to define an individual movement by a grizzly bear. Final results were mapped and an importance ranking for travel was assigned to each trail section, campsite or movement area studied. For each section of travel route, we developed an off-trail/on-trail friction coefficient (one to ten) based on slope gradient, ground cover density, and straight line between prominent landscape features (mountain passes, ridgelines). The number of mark trees per km of lineal pathway was also analyzed. Grizzly movements were also measured against known GIS corridor design attributes including seasonal habitats, riparian zonation, slope gradients, and a "direct line of travel or least path" attribute.

Principal results and conclusions: 92 known grizzly bear movements in the Kakwa Lake Corridor were documented. Results were biased towards a study of grizzly bear travel on park trails and the access road. Some use was also documented of wildlife (non-human) trails. Off-trail movements were not well-documented. Some grizzly bear cohorts (single adults, single/pair subadults) were concentrating movements along specific park hiking trails and abandoned mine roads now used for hiking. However, limited evidence suggests that most mother grizzlies with young were primarily traveling areas off hiking trails and at higher elevations, perhaps in an effort to avoid both large male bears and park visitors. There was a strong correlation between grizzly travel and the frequency of mark or rub trees along hiking and wildlife trails. These are trees that grizzly bears use for rubbing their backs, sides and rumps. Often they stand up to do so. More than 99% (n=136 out of 137) of the mark tree sites were along established travel routes: either hiking trails, abandoned mine roads, or wildlife trails. Of these, 72% (n=99 of 137) of the mark trails were situated in association with trails/abandoned roads used for hiking.

The study thus indicated that grizzly bears in mountain corridors use a variety of established pathways, natural and unnatural, to travel through the landscape. Where human use is low (less than 100 people per week), hiking trails and access roads (no or few vehicles) appear to be well utilized by single adult and subadult grizzly bears. Wildlife trails, hiking trails and access roads have often been developed to follow the path of least resistance and offer the easiest means for bears to travel, even at the cost of bears periodically encountering people. However, where other easier travel options existed for grizzlies to avoid the core Kakwa campsite and HQ facility, grizzlies showed some avoidance by mostly crossing the valley 0.5 km away from the core facility of higher human use. Naturally established wildlife trails were also used where no human trails existed.

Human trails appeared selected for on the basis of direction and least cost of travel, even when the opportunity departed >0.5 km from riparian zones. In general, both humans and wildlife developed established travel routes that appeared to mimic "least cost path". This included slopes of low-moderate gradient. However, established wildlife trail beds also provide easier travel where they cross steeper slopes.

Using the mark tree index, the degree of grizzly bear travel on a specific trail can be crudely predicted. Results were inconclusive in terms of testing against GIS least cost path models. Further field research has been designed to test a random grid of primary, secondary and tertiary travel areas against GIS least cost path models so that the results can be transported to GIS corridor modeling elsewhere in the Y2Y Ecoregion.

Relevance to Conservation in Y2Y Ecoregion:

The information was used to recommend low limits to park visitor use in the Kakwa protected corridor to minimize disturbances to animals that depend on the corridor for travel, feeding and other life requisites. The information has some relevance to conceptual corridor design processes in that corridors should not be designed on the sole basis of one or two parameters such as riparian zone and slope gradient. A variety of complex factors appear to interact to create favored travel routes for grizzly bears within broad corridors. This includes the presence of human trails and access roads with very low human use, which follow obvious "least cost path" lines of travel. Grizzly bear mark trees appear to be a good indicator of the importance of a route/trail/road for travel. A relatively high number of grizzly mark trees (>2/km) indicate a favored travel route. The absence of mark trees or a very low number indicates that few grizzlies travel a route.

EASTERN SLOPES GRIZZLY BEAR PROJECT (ESGBP)

Principal Investigators: Stephen Herrero, University of Calgary; Michael L. Gibeau, Banff National Park; Saundi Stevens, University of Calgary; Bryon Benn, AXYS Consulting

Partnering Organization: World Wildlife Fund Canada

1999

Interagency, multi-stakeholder sponsored research on grizzly bears in the Central Rockies Ecosystem (CRE) began in 1994 as part of the Eastern Slopes Grizzly Bear Project. Most research has focused on the portion of the CRE defined by the Bow River Watershed in Alberta and encompassing major portions of Banff National Park and Kananaskis Country. This geographic focus has primarily reflected funding, not ecology. As part of the research we captured, radio-tagged and monitored 37 female and 34 male bears. Individual bears have been monitored for up to 9 years. By November, 2002, we had collected 9 years of data. Seven Master's and Ph.D. theses and a body of scientific and management publications have been completed (www.canadianrockies.net/grizzly). The field component of the integrated research is completed and we are preparing additional research papers and a final report.

Demographic analysis, lead by Dave Garshelis, has been based on monitoring life history parameters of the radio-tagged grizzly bears. We accumulated 143 bear-years of reproductive information on adult-aged female grizzly bears and were able to back-fill another 12 bear-years. Reproduction was characterized by late age of first reproduction, small litter size, long interlitter intervals and one of the lowest reproductive rates found for a grizzly bear population in North America. Survival rates for adult females were high, between 95-96%. We attribute this high survival of adult females to focused and extended effort by managers to keep individual females alive despite conflict with human use. The high adult female survival supported a high probability of positive population growth (lambda) despite the low reproductive output. This positive trajectory is tenuous because it requires continuing success in keeping individual female grizzly bears alive even though many are habituated and prone to conflict with people. The apparent low density of the population also makes Bow River Watershed grizzly bears potentially subject to rapid decline with small increases in female mortality.

Those responsible for grizzly bear management in the Alberta, British Columbia and national park portions of the CRE agree with the goal of maintaining a non-declining grizzly bear population. This will become increasingly more challenging because grizzly bears in the Alberta portion of the CRE, including Banff National Park, live in one of the most developed landscapes in North America where the species still survives. Adding to the challenge of maintaining grizzly bears, grizzly bear habitat in the CRE is naturally fragmented by rock and ice. Extensive linear developments such as highways, roads and railways follow valley bottoms and further fragment and stress grizzly bear habitat and populations. A large and rapidly growing human population in Calgary (about 900,000) surround intensively used linear corridors, developed sites and backcountry areas in grizzly bear habitat. Recreation and natural resource use and development are primary land uses. In addition to our population research the ESGBP has focused on detailing the nature of fragmentation and human-caused mortalities.

Secure habitat is where grizzly bears have a low probability of encountering people. In secure habitat grizzly bears can feed with little human-caused disturbance and maintain their wary behaviour. The CRE has had extensive and continuous loss of secure habitat for many decades, even inside of protected areas such as Banff National Park. This has primarily been due to fragmentation caused by access and other development encouraging widespread human use. Most recent results show that in the CRE, British Columbia lands, at 50%, had the largest percentage of secure habitat, Alberta provincial lands and national parks both had 43% and Kananaskis Country had 36%. The US Forest Service target for secure grizzly bear habitat is 68%. Percentage of secure habitat that is also high quality was low ranging from 13% in BC provincial lands to 5% in the national park portions of the CRE.

627 of 639 known grizzly bear mortalities in the CRE, 1971-1996, were human-caused. Eighty-five percent or 462 of these, where location could be accurately determined, were within 500 m of a road or 200 m of a trail. Area concentrated mortalities, correlated with access and human use, were found in Alberta near Banff townsite, Lake Louise, the Red Deer River, and in BC in the Elk and Blaeberry Valleys. Of particular concern, in Banff National Park, 1985-1998, female grizzly bears made up 80% of human-caused mortalities.

It is encouraging that the protected population of grizzly bears that were trapped and studied during our research in the Bow River watershed had positive population growth. However, this will be difficult to maintain because of the cumulative effects of the expanding human population and development. To sustain grizzly bears in the CRE at current levels will require integrated management by Alberta, British Columbia and the national parks as these jurisdictions share management of grizzly bear habitat in the CRE. Target values for population, landscape and behavioural conditions will need to be set and achieved within a landscape where many human interests overlap and compete with the needs of grizzly bears.

LANDSAT TM-BASED GREENNESS AS A SURROGATE FOR GRIZZLY BEAR HABITAT QUALITY IN THE CENTRAL ROCKIES ECOSYSTEM

Principal Investigators: Saundi Stevens, Resources and Environment Program, University of Calgary1 and Dr. Mike Gibeau, Dept. of Geography, University of Calgary.2

Partnering Organization: CPAWS - Calgary/Banff

2000

Project Background and Purpose

Maps depicting grizzly bear (Ursus arctos) habitat quality are essential for enabling managers to identify critical areas effectively. Because bears are wide ranging and occupy extensive home ranges to meet their habitat requirements, no single jurisdiction is likely to support a viable grizzly bear population in the long term. Habitat connectivity must be coordinated across multiple jurisdictions, and to do this managers require a common map identifying areas of high quality habitat. In the past, several methods of habitat mapping have been used in attempt to quantify grizzly bear habitat. Much effort has been expended on identifying and mapping grizzly bear habitat based on seasonal food abundance within mapped land units. The shortcoming in these methods is that they do not identify habitat over large areas that cross jurisdictional boundaries. Because of inconsistent ecological mapping methods between jurisdictions, creating a unified or regional scale habitat map has been problematic in the Central Rockies Ecosystem (CRE). Recognizing that grizzly bears use extensive landscapes, crossing many jurisdictions, habitat mapping must be developed and implemented at a regional level or ecosystem scale. The CRE encompasses an area of approximately 40,000 km^2 straddling the continental divide of Alberta and British Columbia; it is one of the most developed landscapes in the world where grizzly bears still survive (Gibeau 2000). The CRE is under great pressure for resource extraction, recreation, and resort and housing development. It is a critical link in the Yellowstone to Yukon landscape because here habitat available for large carnivores is relatively pinched. Careful management based on sound science is required to restrain further habitat loss and fragmentation.

More recently, researchers have used GIS data and satellite remote sensing classifications to predict grizzly bear habitats at regional or landscape scales. This remote-sensing approach to land cover classification avoids the often-prohibitive expense of ground based habitat assessments. One approach entails creating a pseudo-habitat map by transforming Landsat Thematic Mapper (TM) satellite images into greenness bands using a tasseled cap transformation technique. Low greenness values are associated with rock, ice, water, soils etc; where phytomass is low or absent. High greenness values correspond with the abundance and vigor of living vegetation, particularly herbaceous and deciduous vegetation. By incorporating actual grizzly bear location data into the mapping process, we define which greenness values the bears preferred or selected. Subsequently, predictions can be made across jurisdictions for bear habitat quality according to preferences for high greenness values.

Many biologists have identified the importance of female productivity to the viability of a grizzly bear population. Preserving secure areas where female grizzlies can obtain their energetic requirements relatively free from human disturbance is shown to optimize their productivity. Gibeau et al (2001) developed a predictive GIS based model of adult female grizzly bear security areas in the Central Rockies Ecoystem. However, in this model, there is no evaluation on the quality of habitat within the identified secure areas. In order to preserve secure areas it is critical that managers have a tool to identify both secure areas and their quality across the landscape. A valid ecosystem wide grizzly bear habitat suitability map is essential for future planning and policy within the Y2Y corridor.

Overview of Methods and Results

We analyzed seasonal grizzly bear relocation data from two independent grizzly bear projects, each encompassing separate, biologically distinct study areas within the CRE to determine if grizzly bear (Ursus arctos) habitat use can be predicted using a Landsat TM-based greenness (pseudo-habitat) map. Based on empirically determined preferences for high greenness values by female grizzly bears we developed a validated grizzly bear probability of occurrence model and then categorized probabilities to generate a habitat quality map for the CRE.

We updated the existing security areas model with the most recent and accurate human use spatial data for motorized and non-motorized access within the CRE. We overlaid the updated model of adult female grizzly bear security areas with the habitat quality map to identify areas of high quality habitat that are, or could be managed for grizzly bear security. We identified the percent of available land base that is secure high habitat quality across 4 major management jurisdictions within the CRE, across individual bear management units (BMU) within National Parks and Kananaskis Country, Alberta and within individual female grizzly bear home ranges. The percentage of land base in secure high quality habitat is small across the CRE; currently no jurisdiction, BMU or female grizzly bear home range meets USDA Forest Service targets for providing habitat security for long term grizzly bear conservation.

Discussion

We identified specific applications of the secure habitat quality model in grizzly bear conservation and management strategies. These applications include regional access management, landscape connectivity and habitat and/or security restoration. One constraint to using a pseudo-habitat model based on greenness was that we were limited by cloud-free, springtime, satellite images and therefore could produce habitat models for the summer season only. Cloud free satellite images are essential to performing tassel-capped transformations of the greenness bands. A second limitation to using greenness as a pseudo-habitat variable is that the relationships between greenness values and vegetative community types is yet unknown. Therefore, certain management practices may still require site-specific ground investigations. The predictive models of habitat quality and security areas we developed for the CRE are essential tools to assist managers in cross-jurisdictional planning and demarcation of important sites for grizzly bears. These tools will better serve integrated management towards conserving grizzly bear habitat and populations into the long term within the Y2Y corridor.

POPULATION FRAGMENTATION AND CONNECTIVITY OF GRIZZLY BEARS ACROSS BC HIGHWAY 3 IN THE PURCELL MOUNTAINS OF SOUTHEASTERN BRITISH COLUMBIA, CANADA

Principal Investigator: Michael Proctor, University of Calgary

Partnering Organization: East Kootenay Environmental Society

2001-2002

Introduction

This century has seen significant reductions in grizzly bear (Ursus arctos) numbers in western North America. The current distribution of grizzly bears at the southern edge of their contracted North American range inhabit fingerlike mountainous peninsulas, the tips of which protrude into the conterminous United States. Concern over the potential isolation of small local populations and establishment of linkage zones in southwest Canada and the NW USA is becoming a major issue in efforts to conserve this species. Populations in the lower 48 states have been fragmented into four to five populations, several of which rely on linkages with Canadian populations for long term survival. The long-term survival of these southerly populations may in part depend on remaining linked to larger contiguous Canadian population. In particular, the Rocky Mountain peninsula is flanked to the west by two habitat peninsulas, the Purcells and the Selkirks, sub ranges of the Columbia mountains that have a risk of having their southern tips isolated, increasing their risk of local extirpation.

M. Proctor, in related work, reports BC's Hwy 3 and associated human settlement limit female and reduce male movement in the Rocky Mountains of southeastern BC and Hwy 3A restricts movement of both sexes, essentially isolating the grizzly bears in the southern Selkirk Mountains. This evidence has made it imperative to study connectivity in the Purcell Mountains across BC's Hwy 3.

This report discusses work funded by a Y2Y Science Grant where we genetically sampled grizzly bears in adjacent areas north and south of BC's Hwy 3 between Creston and Cranbrook, BC in an effort to determine the amount of connectivity across this human transportation and settlement corridor in the Purcell Mountains. We address the question: is the Hwy 3 corridor a barrier to both sexes, a barrier to a group of bears such as females, open to reduced movements of all groups of bears, or open to significant movements of both sexes?

Methods

DNA samples were non-intrusively collected using 43 hair-grab DNA sampling stations in the best available grizzly habitat over an eight-week period in the summer of 2001. We visited sites to collect samples and refresh scent lures approximately every two weeks. Twenty-six sites were set out to the north of Hwy 3 and 17 to the south. In total we collected samples for four sessions spanning two months. Sites were serviced by vehicle access and foot travel. A sampling station consisted of 1 strand of barbed wire stapled to several trees about 50 cm above the ground with a lure of rotten meat scraps and fish oil hung out of a bear's reach in the center. As bears investigate the scent lure, they leave a hair sample on the barbed wire. Besides genetic sampling in the summer of 2001, we obtained samples that were used within M. Proctor's PhD work from the USFWS, BC Min. of Environment, and other samples collected by M. Proctor. Tissue from hair roots was used as a source of DNA, We generated 15 locus microsatellite genotypes (DNA fingerprinting) to identify individuals and do population level analyses, The genetic lab work was carried out for this portion of the project by Wildlife Genetics International in Nelson BC.

We tested all 15 loci for conformance to the assumptions that underpin our statistical analysis including random mating (Hardy Weinberg equilibrium) within population units, and genetic marker independence (linkage dis-equilibrium). To confirm that the populations we were comparing represented separate breeding groups, we tested for significant differences in allele frequencies. As an index to relative genetic variability we calculated average expected heterozygosity, or the rate of inheriting different alleles (genes) from each parent. We examined for connectivity across Hwy 3 by using individual-based population assignment tests, parentage analysis and genetic distance measures. These methods allow us to determine individual bears that have moved between the populations across the Hwy/settlement corridor and look for a parent-offspring relationship across the Hwy to corroborate the source population of any putative migrants.

Results

We collected 753 bear samples. Of those, 168 were from grizzly bears yielding 29 different individual bears. We captured two individuals south of Hwy 3, one of which was caught on both sides of the Hwy. The other 27 bears were captured north of Hwy 3. This result is not surprising as spring and summer habitat, north of the Hwy is significantly better with many more avalanche paths and alpine areas. Our total database for the southern Purcell Mountains includes 70 bears, 48 captured to the north (23 males, 23 female and 2 undetermined) and 21 bears to the south (11 males and 10 females) and one male captured on both sides of the Hwy. Our analysis for this report is based on this larger data set. Overall we found evidence of four males crossing Hwy 3, all moving from north to south, and no evidence of females crossing the Hwy. One grizzly was known to cross from radio telemetry work (USFWS), and three more bears were identified in this analysis. All had significant parent-offspring relationships across Hwy 3 corroborating their potential migrant status across the Hwy. One of these bears we DNA captured on both sides of the Hwy. Their was no difference in genetic diversity across the Hwy and the genetic distance was 2.07.

Conclusions and Relevance to Conservation in the Y2Y Region

The focus of this study was to determine the level of gender-specific grizzly bear connectivity across Hwy 3 in the Purcell Mts. and we have accomplished this goal. The most striking conclusion is the lack of female movement across Hwy 3. Also interesting is that all male movement was from the north to the south. These results suggests that the small population south of Hwy. 3 in the Purcells (estimated at 25-45 bears) may be a "female island" and is surviving due to its tenuous connectivity to the larger population north of the Hwy. Because human-caused mortality probably limits bear populations in the region, female connectivity would be beneficial for the long-term persistence of the Cabinet/Yaak grizzly population to the south of Hwy. 3, within Canada and extending into the USA. These results are similar to those found in related work done by M. Proctor in the Rocky and Selkirk Mountains (see Intro). The lesson to be drawn from the isolated Southern Selkirk grizzly population is that complete fracture of grizzly bear movement is possible and that continuous human development in association with a major transportation corridor may limit the movement of both males and females. The lesson to be drawn from this study's work is that the Purcells (and Rocky Mountain systems) are probably still experiencing movement across Hwy. 3 and that management strategies still have the potential to maintain and hopefully, enhance inter-population connectivity. We recommend that the potential connectivity zones identified in related work be the focus of an effort to establish special management zones for connectivity. Specifically, the area to the east of Yahk might be given the highest priority as the circumstantial evidence may suggest this is the most likely connectivity zone being used by bears. The area between Kitchener and Yahk should be considered second on the list of connectivity zones. Mortality management should also be considered. Within British Columbia there are two options for mortality management; increased education for a reduction of problem wildlife mortality and consideration of adjusting legal hunting quotas. Close examination of mortality patterns may be useful.

GRIZZLY BEAR CONSERVATION ON PRIVATE LANDS: IMPLICATIONS FOR CONNECTIVITY

Principal Investigator: Seth M. Wilson, School of Forestry, University of Montana

Partnering Organizations: American Wildlands and Predator Conservation Alliance

2003

Purpose & Objectives:

The long-term prospects for conserving grizzly bears (Ursus arctos) in the United States is daunting. Despite decades of effort and scientific research, recovery of grizzly bear populations in the lower 48 states is not assured. The decline of populations in the United States and the southern Canadian Rockies is clearly linked to human causes. Recent work has shown that population trends for grizzly bears in British Columbia, Alberta, Montana, Washington, and Idaho are most sensitive to female survival rates and 77 to 85% of known bear mortality is human caused. The majority of grizzly bear mortality in the US is spatially concentrated on the periphery of core habitats where human activities overlap with large carnivores. These less secure, low elevation habitats are typically privately owned or leased agricultural lands and are of critical importance for research and conservation efforts. Food conditioning of grizzly bears by humans is a primary mechanism that causes conflicts and is a leading reason for management removals of grizzlies from local populations. I felt that research was needed to address the spatially explicit conflict and mortality risks associated with the attributes of human land use activities on privately owned agricultural lands. The primary objective of this research is to identify factors associated with livestock and honey production that predispose grizzly bears to risk of conflict on privately owned agricultural lands in Montana.

Methods

The study area is located on Montana's Rocky Mountain Front (RMF), a region of north-central Montana. The RMF is the only place in the coterminous United States where grizzlies still use their historic prairie grassland range. Approximately 80% of grizzly bear spring habitat on the RMF is found on private lands – primarily fens and riparian habitats. However, the concentration of bear use in this area has resulted in large numbers of human-bear conflicts because of cattle depredation and property damage. More than half of all reported human-grizzly bear conflicts during 1986-2001 were associated with livestock or honey production. Hence, I have focused this research effort on understanding the spatial and temporal nature of livestock management practices and honey production in the study area.

In 1999, I began a census of livestock related land users (n=64) in a defined study area that resulted in a 95% response rate. Livestock related land users included: cow/calf ranchers, sheep producers, hobby ranchers, outfitters, and honey producers. During interviews, I conducted mapping sessions where I've collected spatial and temporal information on calving/lambing locations, spring, summer, fall pastures, and bone yards (carcass dumps) for cattle and sheep operators via a laptop computer. I accounted for 16 years of land use activities in order to integrate these data with a database shared by Montana Fish, Wildlife and Parks (MFWP) on verified human-bear conflict locations from 1986-2001. I used Geographic Information System (GIS) methods to display and analyze the land use practice data and human-grizzly bear conflicts to determine what types of factors affected the likelihood of conflict. I used extensive statistical tests including Monte Carlo Simulations, chi-square tests, Z-tests, and three different logistic regression models to quantify the impacts that livestock and honey production have on conflict occurrence.

Principal Results

I identified five major clusters of conflicts, or what I term, conflict sinks in the study area. Sinks were areas that experienced chronic conflicts over time. For example, all five sinks had seven or more years with conflicts during 1986-2001 and the five sinks contained 78% of all conflicts from 1986-2001. Conflict sinks had the following attractants in common: riparian vegetation present, calving areas, spring cow/calf pastures, and bone yards. Four out of five sinks had unprotected beehives at different times during 1986-2001.

I found through Monte Carlo simulations, that conflicts were strongly associated with rivers and creeks. Sheep lambing areas and spring and summer pastures were also strongly associated with conflict locations. Cattle calving areas, spring cow/calf pastures, fall pastures, and bone yards were also associated with conflicts. The MC simulations to test if beehive protection status was associated with conflicts were inconclusive. However a chi-square test suggested that protected (fenced) beehives were less likely to experience conflicts than unprotected beehives. Conflicts occurred at a higher rate in riparian and wetland associated vegetation that would be expected under an assumption of spatial randomness.

I developed three different logistic regression models to accommodate spatial and temporal variation in livestock and beehive management practices and to account for spatial correlation among randomly sampled points. The potential explanatory variable pool (n=68) including main and interaction terms were systematically reduced through a stepwise process using log likelihood calculations to arrive at 16 variables that were eventually reduced to 6 variables that were common to all three model approaches. I found that the presence of riparian vegetative cover types, cattle calving areas and sheep lambing areas, unmanaged bone yards, and fenced and unfenced beehives all increased the likelihood of human-grizzly bear conflicts.

Conclusions & Relevance to Conservation in the Y2Y Region:

This work has important implications for agricultural landscapes with well-defined riparian ecosystems. As grizzly bears recover former habitats in the Greater Yellowstone Ecosystem and Montana, applications of these finding may be expanded particularly in areas of with landscape connectivity potential. Perhaps most importantly, land use activities like locations of calving areas and fencing status of beehives appear to be factors that contribute to human-grizzly bear conflicts. Solar powered electric fencing of calving areas and beehives are currently proven non-lethal deterrent techniques that should be increasingly utilized within the Y2Y region that support agricultural and grizzly bears. Bone yards or carcass dump removal and or carcass redistribution should continue to be integrated into current state wildlife programs.

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BANFF WILDLIFE CORRIDOR PROJECT

Principal Investigator: Danah Duke

Partnering Organization: Bow Valley Naturalists

1999-2000

Purpose and Objectives

The Bow Valley of Banff National Park (BNP) has been identified as a critical component of the Central Rockies Ecosystem (Green et al. 1996). This regional movement corridor is part of an integrated connection of the Rocky Mountain Cordillera of Canada and the Northern United States for carnivore species such as wolves and cougars. The Rocky Mountain region from Yellowstone to Jasper currently retains a high diversity of carnivore species and offers one of the best opportunities for carnivore conservation on the continent (Carroll et al. 2000). There has been concern that increasing fragmentation in the Bow Valley has reduced the amount of habitat available for wildlife and compromised the connectivity of the landscape, making it difficult for animals to move freely through the valley and the regional landscape (Paquet et al. 1996).

The primary focus of this study was to examine wildlife use of corridors around developed areas in the Canadian Rockies with a focus on the Bow Valley of Banff National Park (BNP). My overall objective was to examine the habitat characteristics important for wolves and cougars as they travel through wildlife corridors at two spatial scales.

I investigated the winter travel routes of wolves and cougars as they move around developed areas. I used these data to determine which combination of habitat characteristics is most important for wolves and cougars as they travel through corridors. The habitat characteristics of interest included both natural and anthropogenic factors including slope, distance to cover, relative prey abundance, corridor width, distance to trails and distance to human disturbance. I attempted to investigate the use of habitat characteristics at a regional and individual scale. My specific objectives included the following:

1. Determine if wolves and cougars select certain classes of habitat characteristics within corridors.
2. Determine which habitat characteristics are most important for wolves and cougars as they travel through corridors.
3. Determine if the use of habitat characteristics is consistent across individual corridors.
4. Determine if the multivariate use of habitat characteristics changes across spatial scales.
5. Examine the differences between wolf and cougar use of habitat characteristics.

Methods

To meet my objectives I snow tracked wolf and cougar movements through corridors over eight winters. These travel routes were entered into a GIS where habitat characteristics were extracted for both travel routes and available habitat. GIS layers were constructed to represent each habitat characteristic. Selection ratios were used to examine the univariate relationships between wolf and cougar travel routes and habitat characteristics at the regional scale. Multivariate analysis of habitat characteristics was conducted using multiple logistic regression. Two scales of analysis were used to develop multivariate models of wolf and cougar use of corridors. These scales included a regional scale (included all corridors), and an individual scale (included each of 11 individual corridors).

Key Findings

I found that there are several habitat characteristics important for both wolf and cougar winter travel routes through corridors. Wolf and cougar preference for many habitat characteristics was similar. In order to optimize wolf and cougar use of wildlife corridors, land managers need to recognize that a combination of key habitat characteristics is required to maximize connectivity around developed areas. I found that wolves prefer flat to gentle slopes in close proximity to forest cover (<25 m), the latter being particularly important in corridors adjacent to high levels of human activity. Wolves preferred areas <50 m from trails. Although wolves are sensitive to human disturbance, wolves used areas close to human disturbance (<500 m) when other important characteristics were present including flat/gentle slopes and high prey abundance. I found that cover was a particularly important characteristic for cougars. They prefer moderate slopes, close to forest cover (<10 m). Cougars also prefer areas <50 m from trails and areas of moderate relative prey abundances. These habitat characteristics do not act exclusively but are part of a combination of habitat features that are important to wolves and cougars as they travel through human-dominated landscapes.

Conclusions

Discerning which habitat characteristics are important and which classes of habitat characteristics are preferred, allows land managers to identify areas that provide optimal movement opportunities for wolves and cougars around developed areas. This information can also be used to identify areas that are insufficient to act as wildlife corridors. For example, this research shows that wolves and cougars avoid open areas around human development. This suggests that areas including open meadows, golf course, ski hills and airfields do not make good corridors. These areas do not provide adequate cover required for wolves and cougars as they move through corridors.

Information from this research can be used in other mountain communities that suffer from human development pressures to identify and maintain effective corridors for wolves and cougars. This research may aid in the maintenance, protection and design of wildlife corridors to enhance connectivity within fragmented mountain environments. As fragmentation and habitat loss continues to dissolve landscapes into isolated habitat patches, corridors will become increasingly important. Identifying important corridor habitat characteristics for wolves and cougars will enhance connectivity and contribute to the long-term maintenance of these species in the Rocky Mountains.

Bow Valley Naturalists

The results of Danah Duke's wildlife corridor research have been, and will continue to be, extremely valuable to the Bow Valley Naturalists in our ongoing conservation work. Threats to the viability of wildlife movement through the Bow Valley arise from proliferating development as well as ever-increasing recreational use, much of it by local residents in Banff and Canmore. Danah's work has demonstrated the effectiveness of corridor restoration and points the way towards proper design of corridors including the need for careful management of human use. It strengthens our case as we argue against inappropriate development and argue for necessary constraints on human activity.

HABITAT SELECTION BY RECOLONIZING WOLVES IN THE NORTHWESTERN UNITED STATES

Principal Investigators: John K. Oakleaf, Dennis L. Murray, Edward E. Bangs, Curt M. Mack, Douglas W. Smith, Joseph A. Fontaine, James R. Oakleaf, Michael D. Jimenez, Thomas J. Meier, and Carter C. Niemeyer.

Department of Fish and Wildlife Resources, University of Idaho, U.S. Fish and Wildlife Service, Nez Perce Tribe, Yellowstone Center for Resources, Yellowstone National Park, Wyoming Geographic Information Science Center, U.S. Fish and Wildlife Service

Partnering Organization: Defenders of Wildlife, USA

2001

Summary

Gray wolf populations have persisted and expanded in the northern Rocky Mountains since 1986, while reintroduction efforts in Idaho and Yellowstone have further bolstered the population. However, rigorous analysis of either the availability of wolf habitat in the region, or the specific habitat requirements of local wolves, has yet to be conducted. We examined wolf-habitat relationships in the western U.S. by relating landscape/habitat features found within wolf pack home ranges (n = 56) to those found in adjacent non-occupied areas. Logistic regression of occupied versus unoccupied areas revealed that a higher degree of forest cover, lower human population density, higher elk density, and lower sheep density were the primary factors related to wolf occupation (Table 1).

The results from each of these formulas were used to generate probabilities for all used and non-used areas, to further examine model performance. The conservative and liberal models both performed well with regards to sensitivity (44 of 56 [0.79], and 49 of 56 [0.88] wolf use areas predicted correctly, respectively) and specificity (44 of 56 [0.79] and 46 of 56 [0.82] non-use areas predicted correctly, respectively). In contrast, false positive and false negative rates were relatively low and ranged from 0.21 to 0.12 for the models. In addition, each of the models predicted site occupation for 7 out of 8 wolf packs that were not used to develop the models.

Upon further model examination and assessment, we selected the liberal model for all subsequent analysis due to its (1) slightly improved ability to predict areas where wolves occur, (2) increased R2 value, (3) greater parsimony. To assess the amount of habitat available in the three recovery areas, probabilities for the liberal model were generated in a 1:24000 quadrangle grids and 9 km^2 grids. We found that the CID recovery region had the greatest amount of preferred wolf habitat (probability = 0.5; 77,596 km^2), while the GYA (45,900 km^2) and the NMT (44,929 km^2) recovery areas had similar amounts of preferred wolf habitat. Further, when wolves are delisted from the ESA, wolf management will be initiated by the three states and our model predicted that at that time the jurisdictional breakdown of preferred wolf habitat will change to 72,012 km^2, 69,490 km^2, and 28,725 km^2 for Idaho, Montana,

and Wyoming, respectively. Currently, our analysis indicated that relatively large tracks of suitable habitat remain unoccupied, suggesting that wolf populations likely will continue to increase in the region. State agencies currently planning to assume wolf management responsibilities post-delisting should consider how new jurisdictional boundaries will affect the amount of estimated preferred habitat within each of the states. Under these guidelines, Wyoming should consistently have the fewest number of packs within the system because of the small amount of preferred habitat relative to that in Idaho and Montana.

Analysis of the habitat linkage between the three main wolf sub-populations indicates that populations in central Idaho and northwest Montana have higher connectivity, and thus greater potential for exchange of individuals, than does either subpopulation to the Greater Yellowstone Area subpopulation. Thus, for the northern Rocky Mountains to function as a metapopulation for wolves and other carnivores (e.g. lynx, wolverine, and grizzly bears), it will be necessary that dispersal corridors to the Yellowstone ecosystem be established and conserved.

Table 1. Parameter estimates for significant variables in a conservative and liberal logistic regression model for wolf habitat selection in the northern Rocky Mountain wolf population. Models were based on 56 wolf home ranges compared with 56 non-use areas.

Parameter	Coefficient	*SE*	Odds Ratio	ΔAIC_c[a]	P[a]
Conservative Model					
Constant	-1.292	1.470			0.379
Cattle Density	-0.377	0.120	0.686	31.036	0.002
Forest Cover	0.031	0.015	1.032	9.702	0.035
Human Density	-0.790	0.381	0.454	8.376	0.038
Elk	1.000	0.446	2.719	3.420	0.025
Other Cover[b]	-0.115	0.054	0.891	2.550	0.032
Liberal Model					
Constant	-4.457	1.722			0.010
Forest Cover	0.057	0.018	1.059	45.994	0.002
Human Density	-0.871	0.326	0.326	11.566	0.007
Elk	1.351	0.474	3.862	7.170	0.004
Sheep Density	-1.735	0.789	0.176	3.020	0.030

[a]ΔAIC values were calculated at the time of entry of the parameter while *P* values are based on the full models.

[b]Other cover represents rock and ice.

INFERRING CONNECTIVITY AMONG ROCKY MOUNTAIN COUGAR POPULATIONS BASED ON GENETIC RELATIONSHIPS IN A COMMON PATHOGEN

Principal Investigators: Roman Biek & Dr. Mary Poss, University of Montana

Partnering Organization: Predator Conservation Alliance, Bozeman, Montana

2000-2003

Purpose and Objectives

There is a strong conservation need for a better understanding of movement and population structure of large carnivores in the Yukon to Yellowstone (Y2Y) region. We have developed a new molecular approach for the assessment of population connectivity for the cougar, a large predator still common throughout much of the region. This approach uses genetic data from a rapidly evolving virus that is specific and common to cougars. The virus, a cougar-specific form of feline immunodeficiency virus (FIVpco), infects 20-60% of cougars in the wild and appears to cause no disease. The promise of this approach lies in the fact that the virus changes its genetic sequence in a matter of years and decades, much faster than any higher organism. Consequently, recent changes in contact rates among host populations should be reflected in the geographic distribution of different virus strains. For example, recently isolated cougar populations are expected to have viruses that are genetically distinct and specific to this region. In contrast, two populations that frequently exchange individuals (and thus viruses) should harbor closely related viruses that are found in both populations. In this way, constructing a genealogy of FIVpco in the Y2Y region becomes a means of assessing ecological connectivity.

Methods

We collected genetic samples from cougars in two ways. First, we obtained samples through researchers conducting field studies of cougars. Secondly, we received samples from cougars killed by hunters in Montana, Idaho, British Columbia and Alberta. Over 200 cougar samples from Y2Y cougars have been collected in this fashion. Using a method specifically designed for the detection of FIVpco, we amplified part of the genetic material of the virus from all infected cougars using polymerase chain reaction (PCR). After determining the genetic sequence for each virus found, the entire set of sequences was used to reconstruct a genealogy tree of FIVpco (i.e. determine the ancestral relationships) across the region.

Principal Results

Figure 1b shows a virus tree from 38 infected cougars, mainly from Montana. The tree reveals that several viral lineages are found in the region (see color-coded branches) with three lineages being particularly widely distributed (yellow, red, green). Geographic distribution for each of the three common types spans several hundred kilometers and in each case reaches across the continental divide. The largest geographic distances between related viruses were found in the red lineage: a virus sequence amplified from a cougar in Banff National Park, Alberta, had close viral relatives not only across northwestern Montana but also as far south as Yellowstone National Park. Branching patterns within lineages further indicated contact among cougars from different areas. For example, we found that cougars in the Little Belt Mountains, which are separated from the Rocky Mountain eastern front by open and less preferred cougar habitat, had viruses closely related to others found west of the continental divide and in Yellowstone National Park. Thus our data do not support prolonged isolation of cougars in the Little Belts.

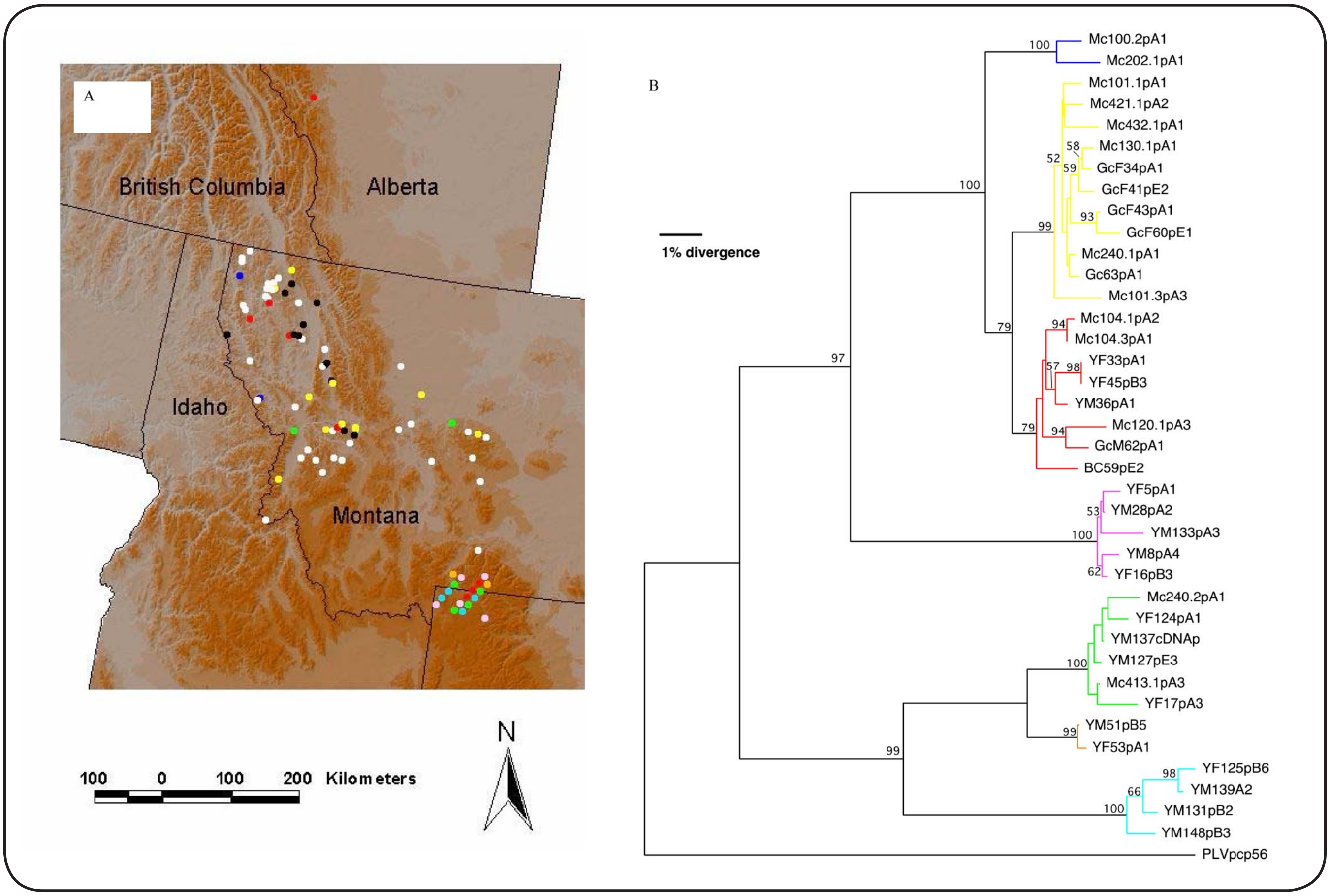
Key Conclusions

Our data to date show that several subtypes of FIVpco are widespread in Montana and possibly over much of the Y2Y region. The large geographic distances between sample locations of closely related viruses imply considerable levels of cougar movement and virus spread over short time frames. We recently estimated that the pol gene of FIVpco (used for the tree in Fig. 1) evolves at a rate of about 1% per decade. Given that genetic distances among sequences within lineages did not exceed 3%, we can therefore infer as a rough estimate that a common ancestor for each of the identified virus lineages must have existed within the last few decades. Thus our results suggest that within the Montana portion of the Y2Y area, and most likely beyond, cougar populations have had frequent contact in contemporary times.

Implications for Y2Y conservation

Our findings, if corroborated by the data currently collected, would have important implications for carnivore conservation in Montana and the Y2Y region. In contrast to other large carnivores in the Y2Y region, cougar populations appear to be well connected over large spatial scales. High levels of movement reduce the possibility of local extinction and facilitate recolonization of formerly occupied habitat. Thus, even small cougar populations at the edge of the current distribution should currently have a reasonable chance of long-term persistence. At the same time, many landscape changes in the region such as road building and development have been most pronounced in the last twenty years. We are therefore hoping to obtain more accurate estimates of the minimum time since populations had been in contact, based on their most recent common viral ancestor, and to possibly identify areas that have been more isolated. Also of particular interest would be whether high levels of contact among cougar populations continue beyond Montana borders, for example into the Canadian Rockies, another question we are currently addressing. Even though it appears that the Y2Y region in large parts is still permeable to cougar movements, it is important to note that this may change as human pressure on the landscape increases. In southern California for example, where cougars have lost a large portion of their habitat to roads and settlements in recent years, populations have become small, isolated, and prone to extinction. Preserving and improving current landscape conditions in the Y2Y region therefore represents a unique opportunity to ensure the long-term survival of cougars as well as many other species with large area requirements.

Figure 1. Samples collected and genetic affiliation of FIVpco sequences. (A) Sample origins. Colors correspond to those shown in B, except for: white = not positive for FIVpco; black = FIVpco positive, but genetic affiliation not yet determined. (B) Neighbor Joining tree of Rocky FIVpco based on pol sequences from 38 individuals.



MODELING CARNIVORE HABITAT-USE, TRAVEL PATTERNS AND HUMAN ACTIVITY AROUND THE TOWN OF CANMORE, ALBERTA

Principal Investigators: Shelley M. Alexander, Paul C. Paquet and Danah L. Duke

Partnering Organization: Wolf Awareness, Inc.

2001

Introduction

The debate that surrounds resource development near protected areas exemplifies the difficulties of making decisions. Often, researchers are unable to agree on the exact effect of development activity, much less on the larger question of how serious the influence is. With so many conflicting opinions, everyone – scientists, the public, and regulators – has been confused about just what the experts know, and how certain they really are. Like many towns within the Yellowstone to Yukon landscape, the Town of Canmore is confronted with this dilemma, as it attempts to balance continued growth with a sustainable environment.

If conservation is to progress, a well-connected network of habitat patches is necessary to sustain the region's wildlife populations. However, to design a large scale system requires a systematic and rigorous approach that integrates the social and economic aspirations of humans with the ecological necessities of wildlife. The focus should not be restricted to "wild lands" but also consider habitat that surround protected areas. This requires a mechanism to address pragmatic issues such as socio-economic needs and to resolve conflicts that inevitably arise between humans and wild animals.

In this report, we outline a computer-assisted decision making process for identifying critical wildlife linkage zones in areas under pressure from human development. The approach is systematic, scientifically rigorous, repeatable, easily documented, and adaptable to new information. The output provides decision-makers with the best available information in a spatially explicit format, which can be used to guide informed decisions. The explicitness of the process can help reduce conflict between different objective groups, as it provides a mechanism for all involved to see exactly what variables were used to examine the issue at hand. This contrasts the too often used "black box" approach to decision making, where stakeholders cannot trace the decision process, which can raise suspicion.

The Canmore Corridor Model

The integrated approach we developed resulted in a decision support model that can be used to reconcile land-use conflicts between the needs of wildlife and humans (see Alexander 1997). We integrated information from current research projects (e.g. Alexander 2001, Duke 2001) and regional spatial data sets. We used a Geographic Information System (GIS) to synthesize ecological and socio-economic data and to examine habitat connectivity under different landscape configurations that account for the needs of humans.

A problem faced in this type of decision process is determining which species to focus research efforts on, as it is not feasible to survey and model all species in the environment. One cost-efficient approach to ecological modeling is to identify and maintain the habitat needs of focal species whose spatial and ecological requirements encompass those of many other species (Eisenberg 1980, East 1981, Noss 1995). The approach assumes that efforts to protect habitat of focal species inevitably help many other species (Power 1998, Doak and Mills 1998, Bow Valley Study 1996, Noss 1995). We used wolves and cougar to develop our decision model, which were selected because of their demonstrated functional ecosystem linkages, available data and because these large carnivores best match the scale of analysis possible with the existing spatial data (Alexander 2001).

Project Objectives

Our approach comprises three integrated objectives.

1. Synthesize existing datasets (ecological and spatial) in the study region.

2. Design a decision framework that models wildlife and human needs in a spatial context. This framework will iteratively examine changes in wildlife linkages with different configurations of human use.

3. Provide the product to regulatory agencies and town officials to integrate the decision framework into protective planning in the Town of Canmore.

Results

The movement pathways we derived from modeling are consistent with local evidence, and can be tested with data now being collected in the Canmore Bow River Valley. We stress that while predicted pathways of the least cost, travel routes of individual wolves and cougar might differ. Nonetheless, the results of this modelling exercise outline probable movement patterns. Our results predict future structural and ecological changes to corridors. These changes are associated with land development and indicate the importance of this type of modelling when determining where mitigation should be developed. In anticipation of unfavorable changes, we conclude that modifications of current development plans are necessary to ensure the continued security of wildlife movement throughout the Valley. We recognize that making unwelcome and potentially costly modifications now, to avoid possible consequences in an uncertain future, is a difficult proposition to see to anyone. Such decisions, however, are easier when informed by unbiased and convincing evidence as is provided by our models.

TRAINING & USE OF SCAT DETECTION DOGS IN WILDLIFE RESEARCH & MANAGEMENT: APPLICATION TO GRIZZLY & BLACK BEARS IN THE YELLOWHEAD ECOSYSTEM, ALBERTA

Principal Investigators: Samuel K. Wasser: Center for Conservation Biology, Department of Biology, University of Washington and Barbara Davenport: K-9 Training Unit, McNeil Island Correctional Center

Partnering Organization: Center for Wildlife Conservation

1999-2000

We report the development and application of a method for using domestic dogs (Canis familiaris) to systematically locate wildlife scat over large remote areas.

DNA extracted from scat is used to determine the species, sex and individual identities of the animal that left the sample at each global positioning system (GPS)-recorded location. These data are layered onto a Geographic Information System (GIS) that also includes geo-referenced habitat measures to describe the association between animal abundance and distribution with environmental conditions.

The canine detection method relies on dogs chosen for their strong object orientation, high play drive, willingness to strive for a reward, and the ability to adapt to new situations and training methods. Once sample detection is paired with receipt of the play reward, these high drive dogs are trained to work throughout the day with little change in search effort. This potentially enables sample detection to occur independent of the subject's sex, behavior and other characteristics that can otherwise violate assumptions of equal catchability typically employed in mark-recapture studies.

The methods were field tested as part of a large investigation of grizzly (Ursus arctos horribilus) and black bear (U. americanus) distributions in a 5,400 km^2 area of the Yellowhead region, Alberta, Canada. Results suggest that the scat canine detection methodology is an efficient, cost-effective and promising means of systematically collecting wildlife scat over large remote areas for use in addressing a variety of critical wildlife management and research questions. Human disturbance appears to have a significant effect on grizzly and black bear land use patterns. Grizzly bears, but not black bears, avoid areas of high tourist use inside the national park, while both grizzly and black bear concentrate in high disturbance, resource extraction areas outside the park. Forage along roads, planted to reduce erosion, coupled with a relatively low risk of being poached, are suggested as possible attractants to the latter disturbance areas.

SOUTHERN ALBERTA CONSERVATION COOPERATIVE: A PROPOSAL FOR CONSERVING LARGE CARNIVORE AND RURAL COMMUNITIES IN SOUTHERN ALBERTA

We envision a regional strategy that combines the tradition and economics of ranching communities with a scientific understanding of carnivore-livestock interactions to sustain the working ranch and large carnivore populations in southern Alberta.

Principal Investigators: Timmothy Kaminski, Charles Mamo, Dr. Carolyn Callahan, Marco Musiani

Partnering Organization: Wolf Awareness, Inc.

1999

Project Background

Lessons of time and experience reveal that protected areas alone are too small to sustain such wide-ranging, large carnivores as gray wolves and grizzly bears (Ginsburg et al. 1998). Efforts to sustain large carnivores at the interface of protected area, private, and rural lands pose a cultural, economic, and ecological challenge: large carnivores that play important ecological roles within and near protected areas have potential to cause economic harm to farm, ranch, and livestock communities beyond reserve boundaries. Consequently, rural and private lands that surround protected areas hold enormous potential for conservation, and for conflict.

Livestock depredations resulting in conflict and culminating in cyclic reductions of wolves and grizzly bears have been repeated across southern Alberta since the turn of the century. Long-term and problem-oriented solutions have not emerged from past carnivore management programs, and the image of southern Alberta ranchers as stewards of public resources has suffered in the eyes of urban publics, and regional and international conservation organizations.

Our research and ongoing extension efforts are exploring a new paradigm for managing large carnivores. A goal is to integrate the shared interests and experience of people with intimate knowledge of large carnivores and livestock into a synthesis of practical lessons to resolve carnivore-livestock conflicts at the interface of private lands and reserve area (public) boundaries. Through work with those closest to the land, and the steps outlined herein, we propose a mutually beneficial approach for conserving the long-term health of the working ranch, and wolf and grizzly bear populations in southern Alberta.

Objectives

Ours is a science-based and solution-oriented approach to address the problem of undervaluing of ranching to conservation in urban communities, and indiscriminate wolf and grizzly bear deaths at the interface of public and private lands in rural southern Alberta.

Objectives of the project to be accomplished in cooperation with ranchers, scientists and Alberta government agency personnel, are to:

1. Compile and synthesize available information on ranching-large carnivore conflicts in the mountains of Alberta, Montana, Wyoming and Idaho;

2. Improve our understanding of seasonal use of private and public lands by large carnivores in relation to domestic cattle and seasonal habitat use of public and private lands,

3. With assistance of area ranchers, rigorously evaluate and link proven depredation avoidance techniques for reducing the magnitude of livestock-large carnivore conflicts to area, habitat, and social dynamics of regionally distributed carnivores, especially grizzly bears and wolves.

4. Evaluate and implement improvements in the existing compensation program for livestock losses.

5. Design and conduct programs to inform and rural and urban audiences about practical approaches to conservation at the private-public land interface.

Principal Findings

- Southern Alberta ranchers use their knowledge of wolf and grizzly bear habits and livestock behaviour to reduce conflicts and losses to large carnivores. Because their understanding of movements and carnivore biology is incomplete, these efforts fall short of meeting their potential for reducing livestock losses.

- Review of depredation histories, repeat offenses and livestock losses demonstrate that proactive efforts to reduce depredations must be year round, and scaled to seasonal (annual in the case of wolves) home ranges rather than site specific or case by case response to depredations.

- Wolves and grizzly bears return repeatedly to investigate areas of previous kills and or food rewards; this provides a powerful mechanism by which to test depredation avoidance mechanisms.

- Those living near such areas respond to large carnivores propensity for learning and associating such areas with food, attractants and repeat conflict; lacking alternative methods to address recurrent depredations, these areas become mortality 'sinks' via control actions, shooting, use of snares, and application of poison.

- Preliminary results show that livestock depredations could be significantly reduced by removing cattle from public and crown lands by 1 September, and that such depredation avoidance mechanisms such as fladry are effective at reducing livestock losses if applied according to explicit protocols and areas of seasonal livestock use.

- A majority of 29 ranches contacted in southern Alberta want changes to Alberta's compensation program that result in prompter service and fairer coverage for the loss of livestock to large carnivores. However, these same ranches were in agreement that it makes far better sense, economically and ecologically, to invest public funds in efforts to prevent large carnivore depredations on livestock than to provide recurrent, partial and therefore unpopular payments as is the current regimen in Alberta. Importantly, these ranchers expressed a willingness to pursue proactive efforts to reduce carnivore-related conflicts.

- Different land use and ownership patterns in areas occupied by large carnivores at the public-private land interface will require different methods for address of conflicts; carnivores ability to learn and adapt to depredation avoidance techniques appears related to the size of their home range and social dynamics.

Key Conclusions

Wildlife management has yet to provide those who might benefit, both ranchers and publics interested in large carnivore conservation, effective understanding and means for reducing carnivore-livestock conflicts. The unapprised, yet critical step in conservation efforts for large carnivores in the Rocky Mountain region is to explicitly address those factors, at the public-private land interface, that contribute to unacceptable losses in ranching economy, and unsustainable mortality in large carnivore populations (Musiani and Viseberghe 2001).

Our ongoing research and work with ranchers represents a practical, science-based and on-the-ground approach that addresses an emergent conservation problem: the lack of a unified approach involving people knowledgeable about large carnivores and livestock, working together to resolve conflicts at the interface of private lands and reserve area (public) boundaries (Weaver et al. 1996, Kaminski et al. 2000).

Contribution and Relevance of Findings to Y2Y Region

Significance of this continuing effort and results lie in the international importance of southern Alberta as a linkage of quality and secure habitat for wolf and grizzly bear movements and dispersal (Paquet 1992, Boyd et al. 1994, Herrero 1995, Gibeau 2000, Callaghan 2002) and in the need for a "working model" for resolving livestock-carnivore conflicts at the private-public land interface in western North America (Weaver et al. 1996, Kaminski et al. 2000).

The Southern Alberta Conservation Cooperative (SACC) is a pioneering, seven-year program that seeks to combine local ranching knowledge with applied research to reduce conflicts between ranchers and large carnivores. Our approach is designed to meet the mutual interests and needs of private landowners in the southern Alberta ranching community by sharing local, first-hand knowledge of the land, native prey and the livestock it supports, and information about grizzly bear and wolf biology, habitat use and movements. By evaluating those conditions associated with past livestock depredations, and incorporating learning from past avoidance methods attempted by ranchers for reducing conflicts, we are designing and rigorously evaluating techniques for reducing the magnitude of livestock-large carnivore conflicts. This shared understanding can support and inform a collaborative conservation program that will mutually benefit ranchers, conservationists, and government agencies, ensuring that economically sound ranching and viable grizzly bear and gray wolf populations remain an integral part of southern Alberta.

Past efforts to reconcile livestock-large carnivore conflicts have been hindered, in part, by the wide-reaching perception that conservation initiatives involving large carnivores and rural communities "benefit some, but not others". The debate that follows erodes support for, and undervalues the benefits to wildlife of diverse habitats and open space provided by large, contiguous ranch operations. Our purpose and current efforts represent our attempt to redress this deficiency.

We gratefully acknowledge the help and contributions of southern Alberta ranch families, Alberta Fish and Wildlife and Parks Canada employees to this effort, especially Bill and Pat Bateman, Mack Main, Bill Dolan, Al Heschl, Howard and Ron Davis, Gary Sargent, Michael and Ann Going, Lou and Don Depaoli, Wayne Schlosser, Stan Wilson (deceased), Lyle Thompson, Hugh Lynch-Staunton, Francis Gardiner, Berns and Lucy Copp, Ken Powell, Larae Nelson, Joe Bews, Dave and Joan Glaister, Bob Perkuss, Bob Jenkins, Stan Hawes, Jon Jorgenson, Steve Donelon, Terry Mack, Pat Ford, Dave George, Ken Powell, Ken Mackay, Kirk Olchowy ,John Clark, Wayne Norstrom, Keith Linderman, and Roger Gluckie.

WOLVERINE ECOLOGY IN THE GREATER YELLOWSTONE AREA

Principal Investigators: Kristine H. Inman, Robert M. Inman, and Rachel R. Wigglesworth Wildlife Conservation Society

Partnering Organization: Wildlife Conservation Society

2001-2003

Purpose and Objectives

The status of wolverine populations in the lower 48 remains uncertain and the ecological requirements of the species are not well described. The scarcity of available information on wolverine ecology is hindering managers who face a number of difficult and important decisions. State and Federal agencies are currently wrestling with issues such as population numbers, habitat requirements, population connectivity, sustainable trapping quotas, threatened or endangered status, and the impacts of winter recreation on wolverines. The Greater Yellowstone Area (GYA) is receiving increasing pressure from human development and recreational use, further escalating the importance of resolving these issues. These human-related activities may be excluding wolverines and other species from important habitats, isolating populations, and/or reducing population densities and fitness. To date, the effects on wolverines remain unknown, and defensible management decisions cannot be made with the current state of knowledge.

The objectives of this study are to:

1. Document wolverine reproductive rates, survival rates, causes of mortality, habitat use, food habits, movement patterns, and home range sizes.
2. Assess the effects of human recreational activities (snowmobiling, fur-trapping, ungulate hunting, skiing, hiking/camping) and commercial activities (housing development, logging, ski resort development) on wolverine populations.
3. Describe inter-specific relationships of wolverines with other large carnivores and ungulates (e.g., grizzly bears, wolves, elk).
4. Identify wolverine dispersal corridors or linkage areas between isolated mountain ranges in the GYA.
5. Recommend management actions and strategies aimed towards the long-term persistence of wolverines in the GYA. Work with agencies, NGOs, and individual landowners to implement management strategies and actions.

Methods

We are studying wolverine ecology in the Madison and Teton Ranges of southwest Montana, western Wyoming, and eastern Idaho. Wolverines are captured from December 1 - March 15 in log box traps. Once captured, they are immobilized and fitted with an internal radio-transmitter or a global positioning system (GPS) radio-collar.

Radio-implanted wolverines are located from an airplane approximately once per week throughout the year. These locations are used to estimate home range size, habitat use, and survival rates, and assist in finding natal dens.

We sample amounts and locations of human recreational use with trail counters, interviews, parking lot counts, and aerial flight surveys. Trail counter accuracy is validated with direct counts during multiple three-hour survey periods. Locations of recreational use are determined with interviews during summer. During winter, aerial flights are used to map extent of use in backcountry locations. Parking-lot vehicle and snowmobile counts are used to estimate total use on each study area and to compare levels of use within an area.

Principal Results

Currently, 11 wolverines are fitted with radio-transmitters, six females and five males. Fifteen different wolverines have been captured thus far; one adult male died in an avalanche and one sub-adult female was legally harvested by a recreational fur-trapper.

Locations from one wolverine (M304) fitted with a GPS collar have provided information on its movements that standard VHF radio-implants were unable to do. In 19 days, M304 traveled over 400 km, from Grand Teton National Park, Wyoming to the Portneuf Range near Pocatello Idaho and back to the Teton Range. Soon afterward, he made a 320 km loop north to the Washburn Range in the northern portion of Yellowstone National Park and back to the Teton Range in eight days. During the same period that we acquired 215 GPS locations for M304, we acquired only six VHF aerial locations, all of which were within the Teton Range. Currently, two adult females are fitted with a GPS collar and one sub-adult male with a satellite collar.

Female home range size averages 520 km^2 (n=3 wolverines and 174 locations). Male home range size averages 840 km^2 (n=2 wolverines and 99 locations). An additional male (M304) has a home range that is an amazing 28,730 km^2 as determined by GPS collar relocations (See picture on poster; n=240 locations).

The majority of recreational use in winter is from snowmobiles in the Madison Range and backcountry skiing in the Teton Range. Snowmobile use in the Madison Range occurs intensively and extensively wherever it is allowed on National Forest Lands. We found peak time of snowmobile activity to occur between 11 am and 2 pm. More detailed results will be available in early summer.

Conclusions

We are beginning to accumulate data on habitat use, survival rates, causes of mortality, reproductive rates, and human recreational use. The low densities at which wolverines exist and the remote areas they inhabit necessitate a dedicated, long-term, intensive field study in order to accumulate adequate data upon which informed management decisions can be made.

GPS technology revealed that a sub-adult male wolverine visited several distinct mountain ranges, crossed major roads, and was in numerous land management jurisdictions (two states, two National Parks, and two National Forests). These data are significant with respect to several issues concerning wolverine persistence in isolated mountain ranges in western North America, including genetic exchange, linkage corridors, and population ecology. Continued use of GPS collars will also enable us to better examine the relationship between human and wolverine activities.

Contribution to conservation in Y2Y

We are building a database on wolverines that will eventually allow for informed federal and state land and wildlife management policies that ensure the long-term persistence of wolverines in the GYA. Expected conservation contributions include an improved understanding of wolverine reproductive ecology, the effect of trapper-harvest on wolverine populations, and the potential effects of backcountry recreation on wolverines.

MAPPING BIRD ABUNDANCE AND COMMUNITY DIVERSITY FROM SATELLITE IMAGERY: VALIDATION OF AVHRR AND MODIS MODELS

Principal Investigators: Kingsford Jones and Andy Hansen, Ecology Department, Montana State University

Partnering Organization: Greater Yellowstone Coalition

2001-2002

Purpose and Objectives

Designing a conservation plan for the Yellowstone to Yukon (Y2Y) Region requires knowledge of critically important habitats for native species and communities. Such knowledge allows for the prioritization of hot spots for biodiversity, key habitats for species of special interest, and corridors between hot spot habitats. Because the vast size of the Y2Y region poses substantial logistic difficulties to mapping and prioritizing habitat quality, developing indices of habitat suitability from satellite imagery offers the best hope of efficiently mapping biodiversity across the entire Y2Y region. In our research we worked to develop and validate methods of mapping avian diversity with models derived from avian survey data and satellite imagery. First, we developed coarse-scale models across five states in the northwestern U.S. Then, within the Montana portion of the Y2Y we developed fine-scale models used to assess the accuracy of the coarse-scale predictions.

Specific Objectives of this study were as follows:

1. Determine patterns of association between predictor variables and bird species richness and use the best resulting models to predict bird biodiversity across the study area.
2. Assess the accuracy of maps of bird species richness derived from coarse-resolution models against fine-resolution models built within the Montana portion of the Y2Y region.
3. Evaluate implications of the resulting patterns of bird diversity across the study area for Y2Y conservation planning.
4. Recommend a methodology for modeling and mapping bird diversity over the Y2Y region.

Methods

Under funding from the National Council on Air and Stream Improvement, we developed coarse-scale models of avian diversity using information available across the five states of the Pacific and Inland Northwestern U.S. (Washington, Oregon, Idaho, Montana, and Wyoming). Models were derived from a combination of Breeding Bird Survey (BBS) data and relatively coarse-scale GIS predictor layers. The GIS layers used to predict avian diversity represented topography, climate, hydrology, land cover, vegetation productivity, and soils. With Wilburforce funding, we then developed fine-scale models of avian diversity within the Montana portion of the Y2Y. These models were developed to advance understanding of the distribution of avian diversity within this portion of the Y2Y, and to help assess the ability of the coarse-scale models to accurately model bird diversity across the rest of the Y2Y. Validation of the coarse-scale methods is highly relevant to Y2Y conservation planning because models at this scale offer the best promise for modeling biodiversity across the Y2Y. Validation entailed testing the ability of the models to predict avian diversity in data not used in model building, and direct comparison of results from both the fine-scale and coarse-scale models.

Principal Results

The coarse-scale maps clearly indicated non-random patterns in regional avian diversity. In particular, the southern Cascade and Siskiyou regions of southwestern Oregon, and the Okanogan Highlands stretching from northern Washington, across the Idaho panhandle and into northwestern Montana emerged as regions of exceptionally high landbird diversity. There was a high level of correspondence between the coarse and fine-scale maps. Within the Montana portion of the Y2Y, both fine and coarse-scale models revealed hotspots of bird richness to be located predominately in the warmer, wetter valley bottoms that are low in elevation and high in available energy. These hotspots are found primarily near the major rivers in northwest Montana (Clark's Fork of the Columbia, Kootenai, and Flathead rivers), and their major tributaries (Bitterroot, Blackfoot, Swan, Stillwater, Yaak, and Bull rivers).

Key Conclusions

We developed maps of bird diversity based on models derived from independent bird monitoring datasets and data layers differing in resolution. Using the maps built with fine-scale predictors and point-count data from within the Montana portion of the Y2Y, we validated the use of a coarse-scale models built at the sub-continental scale. Both models identified hotspots of avian diversity to be primarily located in valley bottoms with a significant forest component along the major rivers of northwest Montana. These valleys are undergoing rapid human development and the results of this study suggest they should be a conservation priority in the Y2Y program. Because we found the coarse-scale approach to be sufficiently accurate, we propose that this method offers the best promise for modeling and mapping bird biodiversity across the vast Yellowstone to Yukon Region, an area too large to model at finer resolutions. These maps would identify other locations in the Y2Y region where biophysical conditions favor high bird species richness, and would provide an objective basis for rating conservation priority for birds in the Y2Y region.

RESTORING SEVERED MIGRATORY PATTERNS OF ROCKY MOUNTAIN TRUMPETER SWANS AND RECONNECTION WITH ESSENTIAL WINTERING AREAS

Principal Investigators: Rod C. Drewien, Hornocker Wildlife Institute and Ruth E. Shea, The Trumpeter Swan Society

Partnering Organization: The Trumpeter Swan Society

2002-2003

Purpose and Objectives

By 1930 Trumpeter Swans were nearly extinct. The only groups that survived in Canada and the contiguous U.S. now breed and winter almost entirely in the Y2Y Region. Although total numbers have increased to over 4,000 that summer in Canada and <400 that summer in the Greater Yellowstone region, essential migratory patterns to diverse wintering areas have been greatly reduced. The security of the western Canadian and Greater Yellowstone nesting populations has been impaired by their reduced numbers and their severely diminished winter distribution.

During the 20th Century, most Y2Y Trumpeter Swans became dependent upon a single wintering area, the high elevation winter habitat of Greater Yellowstone where they are vulnerable to mortality during harsh winters. Rebuilding diverse migrations to other more suitable wintering areas is a primary goal of current Trumpeter Swan management in the Y2Y region.

Conservation groups and wildlife managers currently lack adequate data to determine what actions would most effectively help to expand and diversify migration routes and winter distribution, and which locations should receive management priority. Data are needed to determine:

1. What migration routes are Trumpeters Swans from nesting areas in the Yukon, NWT, AB, and BC currently attempting to use?

2. What wetlands are key stopovers along these routes?

3. What actions are needed to maintain or restore migration stopover sites and to re-establish strong use of these migration corridors?

4. Are Trumpeters attempting to recolonize wintering sites outside of Greater Yellowstone?

5. What actions are needed to increase Trumpeter Swan use of these wintering areas?

6. What areas and management actions should receive priority?

This project's objective was to determine the migration routes, key migration stopover habitats and length of use, and wintering areas of Trumpeter Swans that nest in the Canadian breeding grounds, beginning with the Yukon.

Methods

In July 2002, we captured and marked 15 adult Trumpeter Swans in the central and southeastern Yukon. Swans were marked at sites that were as widely dispersed as possible from Mayo to the Toobally Lakes region, to maximize the likelihood of detecting diverse migratory patterns. Five swans were marked with satellite transmitters (PTTs) and the rest, including the mates of the PTT swans, were neckbanded. Blood samples were also taken for genetic analysis of breeding group relationships, being conducted at University of Denver. Swan locations were determined from data received from Argos satellites and from ground observations of the neckbanded birds.

Principle Results

The five PTT swans initiated migration between 3-22 October and in 15-40 days four birds arrived at winter sites in the eastern Idaho, where they remained through February; one swan collided with a powerline during migration and died near Helena, Montana. All five were found to use the same narrow migration corridor that passed through northeast British Colombia to Grande Prairie, Alberta and then followed the East Front of the Rocky Mountains across Alberta and Montana to eastern Idaho (Figure 1). Distances moved during migration ranged from 1,354 mi (2,179 km) to 1,648 mi (2,652 km). Identified fall migration stopover sites included two areas in the Yukon, three in Alberta, and one in Montana. Length of stay at stopover sites ranged from three to 18 days. Two of the 10 neckbanded Trumpeters have not been sighted since capture; the remaining eight (including four mates of the four surviving PTT swans) were found wintering in eastern Idaho. Four of the five PTTs functioned adequately; one malfunctioned intermittently and will be replaced by the manufacturer.

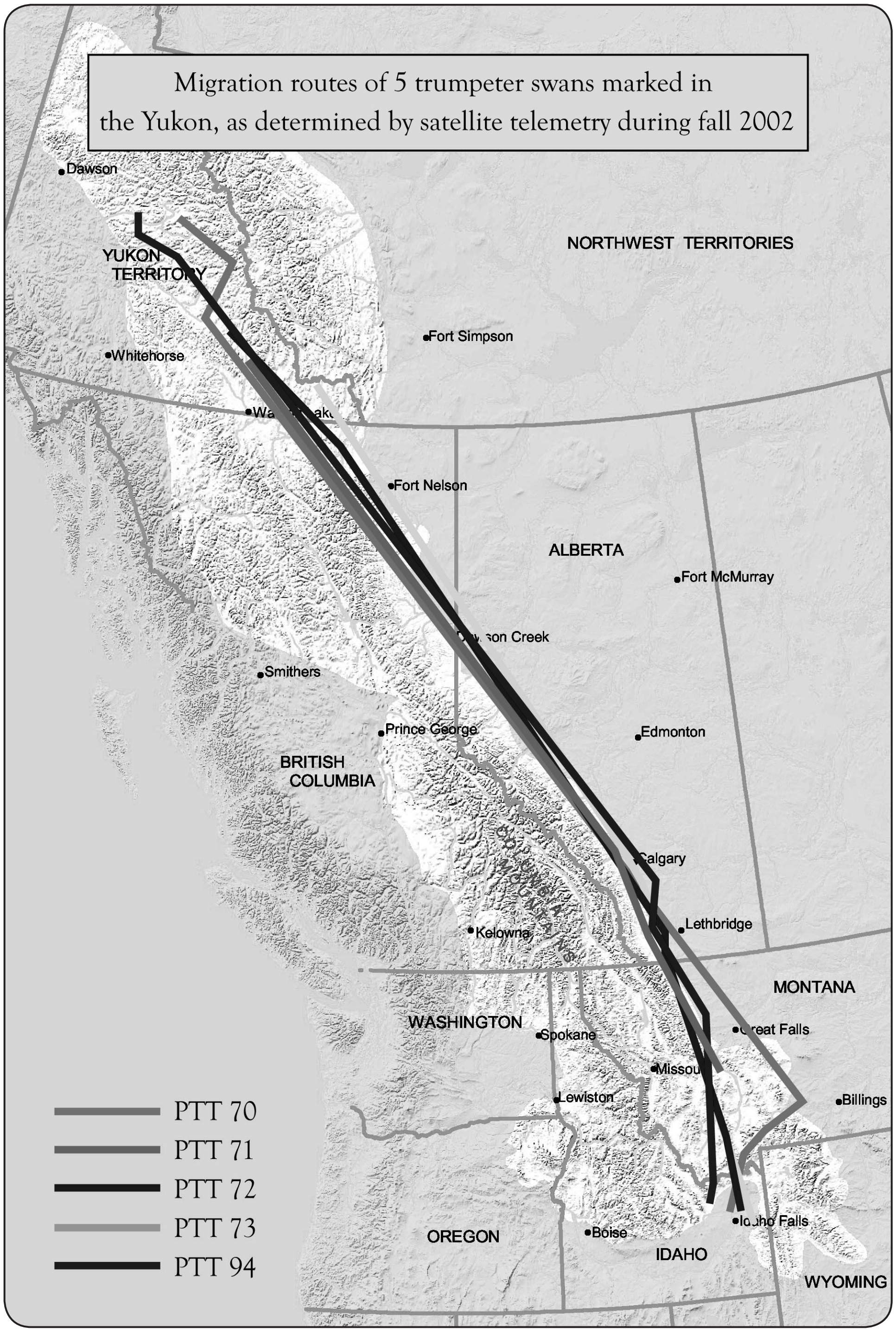
Conclusions

Sample size is not yet adequate to formulate population-level conclusions, and we hope to expand sample size and mark trumpeters in other Canadian nesting areas in Alberta, Northwest Territories, and British Columbia in subsequent years if funding is obtained. Based upon the first year's results, however, the extreme narrowness of the identified migration corridor and lack of diversity in migratory patterns heightens concern for the winter vulnerability of the western Canada breeding population.

Relevance to Conservation in the Y2Y Region

Currently, Rocky Mountain Trumpeter Swans are also most entirely dependent upon habitats in the Y2Y region. Protection of key habitat will be essential to the welfare of both the western Canada and Greater Yellowstone nesting populations. Data regarding key fall and spring migration stopover sites will be used by Alberta during the current development of a recovery plan for Alberta Trumpeters and by other entities who are working to protect key wetland habitats in the Y2Y region. The lack of behavioral diversity found among the small sample of Yukon Trumpeters has surprised managers and heightened concern for the vulnerability of Canadian trumpeters in winter. When the sample size is expanded, the results will directly influence management strategies to disperse Trumpeter Swans to additional wintering areas.

Figure 1. Migration routes of 5 trumpeter swans marked in the Yukon, as determined by satellite telemetry during fall 2002.



AQUATICS

A RIVER INTEGRITY ASSESSMENT FOR WESTERN MONTANA

Principal Investigators: Nathaniel P. Hitt, Dept. of Fisheries & Wildlife Sciences, Virginia Tech, and Leonard E. Broberg, Environmental Studies Dept., University of Montana

Partnering Organization: American Wildlands

2001

Purpose and Objectives

Several methodologies have been developed to assess ecological integrity in aquatic ecosystems. For example, the Index of Biotic Integrity (IBI) assesses stream conditions as a function of fish assemblage structure. Another model, the Aquatic Integrity Areas (AIAs) methodology, integrates abiotic and biotic metrics to assess the integrity of small watersheds (i.e., 6th code hydrologic units). The current project develops a new approach to assess the integrity of large rivers. This River Integrity Assessment (RIA) integrates biotic and abiotic factors to score rivers based on departure from reference conditions. Natural lakes are not included in this protocol, but impounded river segments are (i.e., historical rivers). The results of this project will help in prioritizing river conservation actions as well as integrating terrestrial and aquatic conservation goals. We believe this methodology could be applied to other rivers of the Y2Y region, thereby providing a regional perspective.

Methods

The RIA protocol involves three levels of analysis: 1) river reach delineation, 2) data compilation and meta-analysis, and 3) integrity score calculations and evaluation. All large rivers west of the Continental Divide in Montana were analyzed (>3rd order, Strahler method; approximately 2500 river km). We delineated river reaches at two scales: 1) 10 km reaches -- “reference units” and 2) geomorphically-defined reaches -- “geomorphic units”. Geomorphic units were mapped based on changes in valley form (i.e., transitions from alluvial to confined reaches), gradient, and impoundments. Floodplains for each reach were mapped as the lateral width corresponding to a 50 m rise in elevation from the active channel.

Data collection was organized around four categories that influence river integrity: connectivity, fish assemblage structure, floodplain condition, and headwater condition. Metrics were chosen to quantify river system conditions from local influences as well as from contributing watersheds. Preliminary analyses reduced the number of metrics on the basis of covariation. Metrics lacking strong covariance were used in subsequent analyses. These were: 1) the number of headwater dams, 2-3) distances to nearest up- and downstream dam, 4) cumulative area in upstream reservoirs, 5) non-native fish richness, 6) the number of Corps of Engineers 404 permits issued within floodplain, 7) presence of 303d listed reach for chemical impairment, 8) floodplain road density, 9) percent of floodplain in agriculture, 10) average AIA score within directly contributing 6th-code watersheds, and 11) average AIA score of all upstream watersheds. Metrics within each category (connectivity, fish assemblage structure, floodplain conditions, and headwater conditions) were integrated and normalized to yield a category subscore. Higher subscores indicate a higher degree of river integrity.

To evaluate the relative influence of each category subscore on the final model score, we used a sequential-weighting technique. Each category subscore was systematically inflated by 2x. Subscores were then summed to yield RIA scores, ranging from 0-100. Final scores for each model version were calculated for both geomorphic and reference units. RIA scores were divided into four even intervals (Tiers I-IV), with the highest scores in Tier I areas. The results are relative, not absolute, estimations of river integrity.

Results

All model versions located most Tier I areas within the upper Flathead River system, but varied in the distribution of lower-scoring areas. Additional Tier I areas were located primarily within the Blackfoot and Yaak Rivers. Mid-scoring areas (Tier II and III) comprised the majority of the study area. Low-scoring areas (Tier IV) were distributed widely in sections of the Stillwater, lower Flathead, Bitterroot, and Clark Fork River basins.

Considerable variability was observed among model versions. Relative to a version using equally weighted subscores, the connectivity-weighted and floodplain condition-weighted versions resulted in scores shifted toward Tier I (higher integrity). In contrast, headwater-weighted versions resulted in score shifted toward Tier IV (lower integrity). Analysis of subscore relationships showed some positive associations, with the strongest being that between increasing connectivity and fish assemblage structure (i.e., decreasing non-native fish richness) in geomorphic units ($r2=0.413$, $p<0.0005$).

Discussion

The RIA is a useful tool for assessing the relative integrity of mainstem rivers in a region. This analysis shows an extensive pattern of river degradation in the western MT study area. Tier I areas are largely restricted to the Flathead River system, underscoring the importance of conservation there. The Flathead system is recognized as an important stronghold for westslope cutthroat and bull trout. However, the sharp contrast between Tier I areas in the upper Flathead system and Tier IV areas in lower elevations of the basin highlight the vulnerability of the high integrity areas to potential upstream migration of non-native rainbow trout and hybrids. Upstream vectors from degraded areas present an important threat to the integrity of the last intact region of the study area. The high-quality areas of the upper Flathead, therefore, should be targeted for increased protection.

Relevance to Conservation in the Y2Y Region

RIA scores can also inform restoration strategies. For example, the proximity of lower-scoring to higher-scoring areas may help identify where local restoration actions can have regional significance. The confluence of the Saint Regis and Clark Fork Rivers, the confluence of Blackfoot mainstem and North Fork, and areas downstream from Libby Dam on the Kootenai River are highlighted under this consideration. Additionally, removal of the Milltown Dam at the confluence of the Clark Fork and Blackfoot Rivers would improve several aspects of river integrity in this region: restored hydrological regimes, reduced levels of toxic sediments, and increased connectivity for migratory fishes.

Finally, RIA results, in combination with AIA results and information on wildlife corridors and other critical habitat could be used in concert to plan regional strategies for conservation priorities in the Y2Y region.

COURSE FILTER ANALYSIS OF BULL TROUT (SALVELINUS CONFLUENTUS) POPULATION STRONGHOLDS IN THE COLUMBIA RIVER BASIN OF BRITISH COLUMBIA

Principal Investigator: James Bergdahl, Conservation Biology Center

Partnering Organization: The Lands Council

2000

We conducted a coarse filter, GIS analysis whose objective is to model bull trout (Salmonidae: Salvelinus confluentus) population strongholds British Columbia's (BC) Columbia River basin. We accomplished this goal by overlaying watersheds with known bull trout occurrence with a road density layer. Road density has been well documented as being the best predictor of watershed integrity in the interior Columbia River Basin, and bull trout population strongholds in particular. We used BC's Fisheries Information Summary System (FISS) to estimate bull trout watersheds. FISS has many problems, but it is the best comprehensive data on fish species distribution available for BC. To assess road density we used both BC TRIM (1:20,000) and BC NTS (1:250,000). TRIM is much more accurate, but we did not have access to data for the entire study area. For regions without TRIM, we estimated road density by developing a regression model of NTS road density vs. TRIM road density for a topographically similar region where both data were available.

Two hundred and forty subwatersheds are known to have bull trout, covering ~37% of the BC's upper Columbia River basin. 22% of the watersheds also have brook trout or lake trout - two introduced char that compete or hybridize with bull trout and severely compromise the integrity of bull trout populations. As in the USA, the status of bull trout in BC's Columbia basin appears to be significantly compromised by a number of factors. Only 96 of 240 bull trout watersheds have low road density (~21% of the area of all bull trout watersheds). The majority of the strongholds are in the northern most subbasins of the study area, although others are more widely distributed, such as Wigwam River basin on the BC-Montana border.

Few conservation area designs in the Pacific Northwest focus on protection of fish and aquatic integrity so we compared the level of protection offered bull trout watersheds and bull trout population strongholds by three regional conservation planning strategies: Biodiversity Emphasis Areas (BEA), Grizzly Bear Priority Areas (GBP), and existing protected areas. 112 bull trout watersheds (47%) contained areas of high BEA, about 12% of their combined area. 92 bull trout watersheds (39%) contained areas of high GBP, about 10% of their combined area. With regard to bull trout strongholds, only ~25% of the combined area of bull trout watersheds with low road density lies within existing protected areas.

Our analysis suggests that the status of bull trout in BC's Columbia basin is not much better than in the USA, where the species was listed as threatened under the Endangered Species Act in 1999. Furthermore, the level of protection provided bull trout populations by existing conservation strategies in this region of BC is poor. The results of our map analysis suggest where conservation efforts should be focused to protect remaining bull trout strongholds, and the restoration of ecological connectivity between them. A 2nd year project proposal focusing on an integration of terrestrial and aquatic conservation area designs using BC's Columbia basin as a study area was unsuccessful. The challenges of accomplishing this objective remains largely unexplored in the Y2Y region. We are presently exploring such as task for the transboundary South Selkirks ecosystem.

FRAGMENTATION & LOSS OF RIVERINE WETLANDS DUE TO HUMAN INFRASTRUCTURE

Principal Investigators: S. Bayley, A. Wong and R. Galbraith Department of Biological Sciences, University of Alberta; GIS Analyst

Partnering Organization: Federation of Alberta Naturalists

2000

Purpose and Research Objectives

Wetlands have been identified as high priority areas for protection in the Rocky Mountain regions. They are extremely rare on the landscape and highly vulnerable to changes resulting from human development. They provide critical habitat and movement corridors for both resident and migrant wildlife. Ecological connectivity in a wetland context means that the hydrologic functioning of the wetland is intact. Human activity and infrastructure alters wetland functions, fragments wetland habitat and alters movement of aquatic and terrestrial organisms. Since wetlands provide habitat and wildlife corridors for hundreds of species of plants and animals in the southern portion of the Canadian Yellowstone to Yukon (Y2Y) region, their identification and protection is important to regional biodiversity. Protection of the wetland resource requires basic information on geographic location, the state of the wetland habitats and the degree of impairment.

The conservation objectives of this project are to: 1) identify montane/riverine wetland habitats in the southern Y2Y portion of the Canadian Rocky Mountains, with a focus on the Columbia Trench and the Eastern slopes of the foothills, 2) locate wetland areas that are vulnerable to human disturbance, 3) identify the degree of disturbance within this region, and 4) provide a spatially explicit guide for people to locate wetlands and wetland data in the Canadian Y2Y region.

Methods

The study area covers southeastern British Columbia and southwestern Alberta along the Rocky Mountain corridor. The study area is approximately 7,687,587 ha in size. Digital data were obtained from various sources including the National Topographic Database, and the Canadian Land Inventory. Data were examined at the Canadian Y2Y regional scale and site specific scale. Wetlands were defined by the National Topographic Database as water-saturated area, covered intermittently or permanently with water. Wetland areas and surrounding land use were classified and identified for the study area. Disturbance density for point and linear disturbances were calculated for the wetland areas. To assess the degree of impact of disturbance on the wetlands, we developed an index of disturbance which was calculated as the cumulative number of disturbances within the wetlands. We used this to illustrate the disturbance density in the wetland areas and to help us identify the wetlands that are most likely to be impacted.

Principal Results

The majority of wetlands within the study area are concentrated in 2 main regions within the study area, along the Columbia River, BC and the eastern slopes of the Alberta foothills between Nordegg and Calgary. There are a total 4809 wetlands, covering 54,640 ha, within the study area comprising only 0.71% of the Canadian Y2Y region. Over 67% of the wetlands are within 100 m of a major river (defined as floodplain wetlands) and 32.5% of wetlands are not situated on a floodplain (defined as 'other wetlands'). Over 60% of the mapped wetlands are 1-10 ha in area while very few wetlands exceed 10 ha. The median area of the wetlands is 3.2 ha, although certain wetland complexes are much larger.

Land use surrounding all wetlands is primarily productive woodland, non-productive woodland and unclassified. The most common linear disturbances through wetlands and surrounding areas are cutlines and local roads. The highest density of linear disturbances in wetlands is found between Nordegg and Calgary, AB. Although roads may not directly intersect wetlands, they can intersect nearby streams and rivers potentially having a dramatic effect on the hydrologic functioning of a wetland. Most road-stream intersections occur when secondary highways and local roads intersect small tributaries. Expressways, major highways and principal highways mostly intersect larger streams and rivers. Wetlands are also disturbed by flooding from reservoirs and of water starvation and altered hydrology downstream of reservoirs which results in loss of riparian habitat. Analyses regarding the impact of reservoirs are currently in progress. A disturbance index of total number of disturbances will also be calculated to identify wetland areas that are least impacted by disturbances.

Key Conclusions

1. Wetlands are very rare within the Canadian Y2Y region and are mostly concentrated into 2 main areas: the Columbia Basin and the eastern slopes of the Alberta foothills.
2. Wetlands are primarily surrounded by productive woodland, unclassified and non-productive woodland.
3. Wetlands are mostly fragmented by smaller linear disturbances such as local roads and cutlines. Although the disturbance impact of these smaller roads may be less, it is the density in which they occur that can increase their disturbance severity.

Relevance to Conservation in the Y2Y Region

Wetland conservation within the Canadian Y2Y region is essential to maintaining regional biodiversity and habitat connectivity. However, wetlands are extremely rare and are fragmented by numerous disturbances. Wetlands will be increasingly fragmented and degraded with continued exploration for oil and gas and road developments. Our research identifies the geographic location of wetlands and degree of impairment within these wetlands. This project was also developed to facilitate data sharing among conservation groups and to report on the status of wetland habitats in the Canadian Y2Y region. This research can be used to obtain information about wetland habitats and will complement other studies focused in that region. All GIS information resulting from this project will be given to the Federation of Alberta Naturalists which will provide this data to conservation groups, educators, researchers, community groups and wetland managers.

DOCUMENTATION OF PRONGHORN MIGRATION DYNAMICS RELATIVE TO A CONSERVATION EASEMENT IN THE UPPER GROS VENTRE DRAINAGE, WYOMING

Principle Investigator: Tom Segerstrom, Wildlife Research Services

Partnering Organization: Jackson Hole Land Trust

2002

Project Background

A singular pronghorn antelope migration route, one that stitches together the ancient ecological connections between Grand Teton National Park and the southern extremes of the Greater Yellowstone Ecosystem (GYE) has recently been formally documented. This particular, 150 mile (240 km) migration by pronghorn appears to be the third longest migration of wingless mammals in the world, exceeded only by the Porcupine caribou herd in the artic regions of Alaska and a wildebeest herd on the Africa's Serengeti Plains.

The formal documentation of this route, and years of some focused attention by certain groups, have enabled the specific identification a small set of well-defined natural and human-influenced bottleneck or "pinchneck" locations along this route. Due to rampant energy development, and a virtually unfettered potential and historic bent toward suburban or commercial development, the migratory function several of the bottleneck sites is threatened. So too is the bio-diversity of a national park and indeed the GYE by the potential degradation of a wildlife movement corridor that has been proven to be at least 5,600 years old.

Only two of the approximately 8 potential bottleneck areas have been protected since knowledge of the sites has become commonplace. Private individuals acting through the Jackson Hole Land Trust, (JHLT) in one case in coordination with the Bridger-Teton National Forest (BTNF), have made both of the protection efforts a reality.

Purpose and Objectives

This study was funded entirely with a Y2Y Conservation Science Grant with the intent to document, in detail, the spring pronghorn movement across a small area of public lands surrounding a private parcel that was recently protected with a conservation easement. The purpose of this study was to understand the nature of the pronghorn migration at this particular location at a detailed level, and to provide the information to the landowners to guide their land use decisions in regard to maintaining a viable means for the pronghorns to reach their natural seasonal ranges, and perpetuate one of this planet's true wildlife phenomena. Currently, the public lands in the study area support a high level, and a wide variety, of uses from gravel mining and off road vehicles, to hiking, fishing, and camping. The private landowner donated a conservation easement to the JHLT to limit the land uses on the parcel to agriculture, but they also retain several other reserved rights, including a residence on the 160 acres.

Specific details regarding the preferences, and patterns of the pronghorn movements in this location, which often reflect the energetic requirements of pronghorn, were needed by the landowners. Changes in the land uses in this area could unintentionally degrade the ability of the pronghorn to migrate. By the same token, unnecessary, or ineffective constraints on land uses that would not affect the pronghorn, but are enacted nonetheless due to fear and ignorance, are now understood and can be avoided.

The research objectives were straightforward: capture on time-lapse video the nature of pronghorn migration movements through the study area, quantify the timing and numbers of pronghorn migrating, and try to identify specific pathways, routes, and features that were selected by or appeared important to the pronghorn by observation. The ultimate goal, of course, was to attempt to present to affected parties in a variety of written and visual media, the nature of this sporadically witnessed wildlife event that would be important to conserve.

Methods

The methods for this study were just as straightforward. By placing a standard video camera, with a time-lapse feature, into a small blind constructed from a garbage can, the study area and the majority of the spring migration could be continuously observed by letting the camera run for 30 days between May 15th and June 15th. The camera station was visited every 4 days, and by reviewing portions of the exposed film in the field, new camera angles and views could be selected during the migration to learn more about specific aspects of the migration. Just as importantly, lack of observations on the film indicated the locations and features that were potentially unimportant to pronghorn.

The data was collected at a cost of about $800 in equipment and supplies inside of 30 days, with only 36 hours of actual field time. Analyzing the data and presenting the results to all parties in a variety of media required another 69 hours. Figure 1 best illustrates many of the questions and anecdotal observations that were confirmed and supported by the results. Of course, the results also brought into focus a couple of small mysteries, such as, exactly where the pronghorn prefer to cross the Gros Ventre River, but the answers to those questions are likely to fall into place with small amounts of future passive observation.

Key Findings

The key conclusions that we believe the study will make evident to the landowners involved are that:

- The migration route appears to be influenced by the 6-strand barbed wire fence that surrounds the private parcel but not in a particularly negative fashion.
- The pronghorn that appear to be migrating pass through the fence frequently, and their movement pattern is more heavily influenced by key foraging areas (See Figure 1) and the social presence of other pronghorn, both migrants and local pronghorn.
- There was no indication that the current level of human activity or structures at that time of year was influencing the migration.
- Direct observations indicated that pronghorn might have difficulties passing through the fence on the western edge of the private parcel, which could be a perfect candidate location for a fence adaptation such as a gate that the JHLT

could facilitate, if the landowner is open to the concept.

- There was no indication that the northwestern portion of either the private land or the Forest Service land directly north of the protected property was used to any significant degree during the migration.

As would be expected, given pronghorn antelope behavior, the majority of the migratory movements appeared to take place during the mid-day hours and involved about 103 individual pronghorn during the 30 day period. That total translated to about 43 percent of the pronghorn that were captured on film. The peak of the migration appeared to be June 5th through the 8th. All of the pronghorn that crossed through the 6-strand barbed wire fence did so by crawling under the bottom wire, and about 21 percent of the pronghorn that were migrating crossed the fence to interact with other pronghorn or to forage on the irrigated vegetation. A specific foraging area, as well as the irrigated forage within the private parcel (Figure 1), appeared to naturally attract pronghorn to the fence line, rather than the fence line intercepting the desired migratory pathway of the pronghorn.

Contribution and relevance of findings to conservation in Y2Y

This particular migration is a crystal clear symbol of the type of ecological function that the Y2Y Initiative is focused upon conserving, and it easily captures the minds of conservation-minded North Americans. While this research was very fine-scale in its scope and focus, pronghorn most likely make life and death decisions based on land use patterns in every kilometer-long stretch of the route as it unfolds before them on their step-by-step migration along this 240-kilometer sojourn. Similarly, due to the existence of bottlenecks, conservation of this migration route will truly be accomplished only at this a similar scale. With the information gained, informed land use decisions can be made, and benchmark of the current patterns has been recorded. Just as importantly, unnecessary land use restrictions based upon fear of the unknown can be limited, while preserving the live blood of the larger landscape and ecological system.

BOZEMAN PASS WILDLIFE LINKAGE AND HIGHWAY SAFETY STUDY

Principal Investigators: Lance Craighead*, April C. Craighead*, Elizabeth A. Roberts^, and Michael J. Rock* *Craighead Environmental Research Institute, ^American Wildlands

Partnering Organization: Craighead Environmental Research Institute with American Wildlands

2001

Purpose and Objectives

This study began in 2001 to identify the problem areas for wildlife and human safety at Bozeman Pass and make recommendations about how and where to mitigate wildlife mortality and human safety issues in the connectivity zone. Previous regional scale connectivity modeling by some of the authors identified Bozeman Pass as an important movement corridor with significant barriers for wildlife. Barriers caused by roads and railways pose a significant impediment to wildlife movement at all scales throughout the Yellowstone to Yukon area, and a risk of injury or death to animals. In turn, animals on highways pose a risk to motorists and property damage to vehicles. As traffic volumes increase, these risks also increase. Bozeman Pass experiences significant conflicts with wildlife at the present time. In addition to a four-lane highway (Interstate 90) there are parallel frontage roads and a railway.

Objectives include:

1) Determine the extent of wildlife human safety conflict at Bozeman Pass, including the location of most wildlife vehicle collisions. 2) Identify the current and potential wildlife use of the linkage zone for various species. 3) Determine the best site for wildlife crossing mitigation projects. 4) Collaborate in design of the type of mitigation structure most appropriate for its location on the landscape and most effective for wildlife passage. 5) Protect adequate habitat on either side of crossing structures on private and public lands so that animals can approach and leave with security. 6) Disseminate the methodology and results throughout the Y2Y region.

Methods

Methods employed in this project consist of GIS methods and field methods. Habitat connectivity modeling, using GIS habitat suitability and least-cost-path models, was done to identify the best wildlife habitat on both sides of the highway, and the shortest movement routes, through the best habitat, across the highway. Using GIS layers of landcover and human disturbance, a "cost surface" is derived which represents the difficulty (cost) to an animal to move through the landscape. Core areas of good habitat which offer security (little human disturbance) are selected based upon expert opinion; and least cost paths are calculated between pairs of core areas. A map of probable movement habitat results; this represents the best habitat over the shortest cumulative cost-distance between cores. This can be considered one quantitative measure of relative "connectivity".

The model results were compared with field data consisting of roadkill and winter track locations. Initial road-kill data and winter track surveys were collected over a two-year period. Remote cameras were used to photograph animals crossing in front of the camera at key sites such as underpasses and culverts.

Principal results

At least 127 mammals were killed in 2001 on this section of Interstate Highway 90; in 2002 the total was 180. Using all data sets, a location for crossing mitigations was selected. To make the project cost effective, wildlife crossing options were designed to be included in a scheduled construction project: the Montana Rail Link bridge re-build. Once the site was selected, and agreement was reached with the Montana Department of Transportation and Montana Rail Link, a project was designed to include wildlife safety fencing, moose/cattle guards at on-ramps, and landscaping to re-direct animals under existing bridges and through existing culverts. In consultation with local land trusts, landowners, and conservation groups, wildlife habitat is being protected on both sides of the highway near the crossing sites.

Results of this analysis indicate that GIS least-cost-path models help to identify locations where animals attempt to cross the highway. GIS maps currently summarize location data for wildlife vehicle collision, wildlife movement habitat, secure wildlife habitat, and potential sites for wildlife crossing structures. Several moose, mountain lions, black bear, one pine marten and one wolf have been killed by traffic. A sensitivity analysis of habitat thresholds for depicting crossing sites (corridors) indicates that animals are not necessarily crossing in the best habitat, but attempt to cross near the best habitat. Maps and models of movement habitat can be combined with field assessments and additional data such as road kill locations and track surveys to locate the best crossing sites. Maps and models of movement habitat are useful for identifying secure areas adjacent to the highway where animal movement corridors can be maintained.

Key conclusions

Static habitat connectivity models can identify the best habitat in terms of security and animal preference; currently they can not predict actual movement routes which are subject to many additional variables. Topography and highway surfaces; barriers such as fences, Jersey barriers, embankments; and traffic noise and volume, act to change the movement patterns of animals as they near the highway. Models of habitat connectivity, or corridors, are useful to help locate probable crossing locations, and are very useful at identifying secure habitat adjacent to highways.

The contribution and relevance of the research findings to conservation in the Yellowstone to Yukon region.

In the absence of accurate empirical data, these models are useful to identify potential crossing sites, and should be applicable across the Yellowstone to Yukon region with appropriate modifications for local species preferences. Once identified, the potential crossing site locations can be inspected on the ground in order to determine the best mitigation sites.

MULTI-SCALE GIS APPROACH TO MODELING ANIMAL MOVEMENTS ACROSS TRANSPORTATION CORRIDORS IN MOUNTAINOUS TERRAIN

Principal Investigators: Anthony P. Clevenger, Faculty of Environmental Design, University of Calgary & Jack Wierzchowski, Geomar Consulting Ltd.

Partnering Organizations: Bow Valley Naturalists and the Friends of Banff National Park

2001-2002

Introduction

There are few places in the world where the intersection of transportation corridors with wildlife corridors is as significant as in the Central Rocky Mountains. Banff and Yoho are the only national parks in North America bisected by a major transportation corridor. With mean daily traffic volumes on the Trans-Canada Highway (TCH) ranging from 15,000-35,000 vehicles per day, the highway presents a serious obstacle to the movement of large mammalian carnivores and their prey. For this reason 24 wildlife crossing structures were installed along 45 km of TCH in Banff's Bow Valley. Plans exist, however, to construct mitigation measures on an additional 30 km of TCH within the next 5-10 years.

The Bow Valley contains the most important transportation corridor in the region. Maintaining the viability of the valley as the primary wildlife habitat and migration area in the park while allowing its use as a safe transportation corridor poses a challenge to park managers. As part of a project aimed at evaluating, designing and planning highway mitigation measures along the TCH in Banff National Park, Alberta, we developed a GIS-based approach to modeling animal movements across transportation corridors in the Central Rocky Mountains.

The purpose of this work was to provide park managers with an empirical assessment of the impediments transportation corridors pose to the regional movement patterns of wildlife and recommendations concerning the placement of mitigation measures along the TCH. Our objective was to model animal movements across transportation corridors in the Central Rocky Mountains using a regional-scale, GIS-based approach. Specifically we (1) developed regional habitat suitability models for Wolves, Grizzly Bears, Black Bears, Elk and Moose, (2) created regional scale habitat linkage models for the five species, and (3) nested within objective 2, created local-scale models indicating the location of potential highway mitigation based on the intersection of linkage pathways with transportation corridors.

Methods

We focused on the unmitigated section of the TCH in the upper Bow Valley of Banff National Park. High resolution, habitat suitability models were created for the five large mammals. We used individual-based models with rules for simulated movements based on habitat quality and permeability of landscape features. We simulated movement patterns using 11 potential entry and exit points located on the periphery of the study area. Entry-exit points coincided with the regional movement corridors identified in previous modeling efforts. We simulated animal movements from all possible combinations of entry and exit points. We tested the accuracy of model predicted highway crossing zones with empirical data.

Principal results

We generated nine habitat suitability models from the five species data sets. All habitat models showed a good fit with the empirical data. Statistical tests of our model results showed that movement simulations consistently conformed to the empirical data on highway crossings by animals. For testing the cumulative model pathway intersections, we used road-kill locations from seven species. The empirical locations were significantly closer to the modeled high frequency crossing zones than expected by chance. We also analyzed the attributes of highway crossings with the average highway conditions. We found there were strong similarities among the investigated models. Although not always statistically significant, a clear pattern of association with lower noise levels, higher habitat quality, and relatively abundant open vegetation characterized areas of both successful and unsuccessful highway crossings.

Key conclusions

Our modeling results are currently providing land managers and transportation planners with key information needed to identify the most suitable locations for placement of wildlife crossing structures in future highway improvement and mitigation projects in Banff National Park. Further, we believe our work and the trends identified in both analyses constitute a good starting point in a qualitative assessment of the conditions conducive to wildlife-vehicle collisions. We highlight the wide applicability of models like ours to other planning issues in the Yellowstone to Yukon region.

Contribution and relevance of the research findings to conservation in the Yellowstone to Yukon region

Major transportation routes, especially those through ecologically sensitive, low elevation valley bottoms present some of the most severe land-use conflicts in the Y2Y region. In fact, the so-called "hot spots" within Y2Y, where the freedom of wildlife to move through the landscape without serious risk of mortality has been most seriously constrained, tend to be associated with transportation corridors. These conflicts are compounded when there also are significant levels of human activity and development such as in the Bow Valley in Banff National Park. The value of this research project is that it not only identifies site-specific concerns and proposed mitigations for a particular highway in a particular valley, it suggests a way of thinking about these kinds of problems and indicates the type of information required in the quest for solutions.

The Bow Valley Naturalists and other conservation groups will be able to use these results to push for suitable design of mitigations along the next phase of twinning of the TCH as well as necessary retrofits along the sections of highway already twinned in the park. Design principles and the process for adapting them to specific locations will be readily transferable to other highways in other valleys including areas such as the Crowsnest Pass where the vital ecological connectivity of Y2Y is so threatened. And the potential to adapt the models for application to railways or even trails implies opportunities for designing new infrastructure or taking restorative action with existing infrastructure in a way that truly accommodates the needs of wildlife.

ROADS AND THE INDUSTRIALIZATION OF NORTHERN BRITISH COLUMBIA

Principal Investigator: Roger Wheate, University of Northern B.C; NGO Investigators: Bob Peart and Bruce Hill, CPAWS-BC; Pat Moss, NWI

Partnering Organizations: The Northwest Institute and CPAWS - B.C.

2002

Purpose and Objectives

The objectives of this project included documenting and analyzing the ingress of road networks in Northern BC, 1950-2000. Our efforts were intended to create a series of time specific snap shots for each of the last five decades. These objectives are now recognized as somewhat ambitious under the initial funding, but layers have been assembled for 1980 and current (2000). Subsequent layers for earlier decades and 1990 could be assembled in future using recently acquired aerial photography.

Within the Y2Y region, existing databases and maps show a clear gap in northern BC for the designation of existing roads (as illustrated in Y2Y: Sense of Place). This study sought to fill that gap and further to provide a temporal analysis of the growth of roads for this area.

Methods

We focussed on the Mackenzie Forest District and adjacent areas to the west, with the advantage of a fixed start to road building in the Mackenzie area following the construction of the Bennett Dam, creating Williston Lake Reservoir in 1967. The adjacent corner of the Prince George District to 122 degrees west was included as it represents the narrowest 'collar' of the Y2Y region. Various sources were investigated for data layers:

- British Columbia's Terrestrial Resource Inventory Management (TRIM) at 1:20,000 and 1:250,000: TRIM I (1986-96) and TRIM II (1997-2002)
- Forest District appended road coverage and Forest Licensee road inventories (current)
- Statistics Canada, DMTI and BC Digital road atlas (these do not include forestry roads)
- National Topographical Database (NTDB) digital layers at 1: 50,000 scale (1970-95)
- National Topographical Society (NTS) 1:50,000 scale paper maps (1970-95)
- Aerial photographs (1950s-1980s) and satellite images (1984-95)

We used a combination of TRIM and forest district roads to generate a 'current' layer. In other portions of BC, it may have been possible to create a 1990 layer from TRIM I, but here there is only a few years difference between TRIM I and II. The 1980 layer was created using NTS 1: 50 000 scale maps which are produced over a range of dates limiting the ability to create a complete roads coverage of the study area for a given time period. However we used 1980 as the mid date. The level of generalisation for NTS 1:50,000 scale maps is similar to that of TRIM II roads making these two sources comparable.

Total road lengths were calculated for the past and present road layers to create an overall linear disturbance density per square kilometre for the study area. Buffers at 100 and 500 metres were also applied to calculate area affected by linear disturbance, assuming these were meaningful values for impact on wildlife. The 500 metre buffer, constituting a one kilometre wide swath surrounding a road was suggested in 'Sense of Place' (p.62). The remainder is considered relatively unaffected by linear disturbance.

Principal results

The total length of roads in the study area has approximately trebled between 1980 and 2000, and similarly the linear disturbance density (table 1), although by less than a factor of three, due to overlapping of adjacent buffers, especially as buffer size is increased. The average density remains less than half that of the Y2Y area as a whole, although just as northern BC (and Yukon) have lower densities in general, so the northern and remoter parts of these areas have even lower densities, that is, very few roads in the northwest parts of the Fort St. James and Mackenzie districts. Mean disturbance density overall was only 0.10 for 1980 and 0.22 for 2000 (compared with 2.7 for the Alberta portion of Y2Y).

Key conclusions

Completion of road layers for other times (1950s, 60s and 70s) can be done only using aerial photographs which are flown far more often than maps are produced. Air photos can be used to determine the presence / absence and (less reliably) access status of roads at a particular time. These photos are in the process of being acquired by UNBC as a result of BC government district office closures and will be in place for further analysis in late 2003.

Contribution and relevance to conservation in the Yellowstone to Yukon region

Work on this Roads of Northern BC Project has improved appreciation of data availability and limitations, and led to a better idea of the methodology required to reconstruct the history of our backcountry roads. This area represents a prototype of early road development within the Y2Y region. Road density is lower only in the Northern Rockies and the Yukon.

Table 1. Linear Disturbance, 1980 and 2000

a. Date	Length of roads (km)	Total area (sq km)	Linear Disturbance (density km/sq km)
1980	10,380	128,245	0.081
2000	31,331	128,245	0.244

b. Date	Buffer (m)	Area (sq km)	% of total area
1980	100	2,014	1.57
2000	100	5,965	4.65
1980	500	8,889	6.93
2000	500	22,284	17.38

PRELIMINARY EVALUATION OF THE ROAD OBLITERATION PROGRAM ON THE CLEARWATER NATIONAL FOREST, IDAHO

Principal Investigators: Amy Chadwick and Mark Vander Meer, Watershed Consulting and Marnie Criley, Wildlands CPR

Partnering Organization: Wildlands Center for Preventing Roads

2001

Purpose:

The Clearwater National Forest (CNF) covers 1.8 million acres in north-central Idaho. Because the Clearwater has the habitat to host a full spectrum of carnivores, and the ability to serve as refugia for a variety of sensitive species, the World Wildlife Fund calls the region the most important high-priority area in the U.S. Rocky Mountains for carnivore protection and restoration.

With nearly 4,500 total miles of roads on the CNF, some areas of the forest have road densities as high as 30 mi/mi2. In 1998, the Clearwater began an intensive road removal program, with emergency federal funding they received after extensive flooding and road-induced landslides in 1995-1996. With a goal to remove 100 miles of roads per year, they have currently removed over 450 miles.

While many National Forests around the country are engaging in limited road removal, few, if any, are doing so at the scale of the CNF. For this reason, Wildlands CPR, a conservation organization based in Missoula, Montana, contracted with Watershed Consulting, LLC to assess the road removal program on the CNF. Our goal in writing this evaluation is to increase the ecological benefit of the CNF road removal program and provide information to improve the ecological benefits of other road removal programs.

Objectives:

1. Determine if the CNF removed the right roads to preserve or restore watershed integrity and landscape regional connectivity.
2. Determine if the CNF removed and restored roads in a way that will help restore terrestrial and aquatic habitat.
3. Evaluate the effectiveness of the road removal efforts to restore ecological function at the road sites and prevent motorized access.

Methods:

Watershed Consulting conducted road inventories and assessments of obliteration efforts in three primary focus areas: 1) West Fork of Fishing Creek 2) Badger Creek drainage 3) Wendover Creek drainage. We chose the three study drainages to represent a variety of conditions and ages of obliteration efforts.

Watershed Consulting developed a road inventory process to assess CNF road obliteration efforts. Road inventory forms used in the field assessment included the following:

- Location information
- Road closure status (open, closed, obliterated, long-term intermittent use)
- Closure type (berm, gate, ripped surface, abandoned/overgrown, etc.)
- Road type (e.g. graveled arterial road, two-track dirt road, asphalt, etc.)
- Vegetation cover on surface and cut and fill slopes
- Presence and identification of noxious weeds
- Description of revegetation treatments (e.g. seeding, duff recruitment, planting, etc.)
- Obliteration techniques (ripping, mulching, outsloping, etc.)
- Type and condition of stream crossings
- Location, type and severity of erosion
- Indicators of modification of hydrology (e.g. pooling, flow on road, ditches, etc.);
- Photo descriptions and other comments.

Principle Results:

Obliteration Methods

The main strength of the CNF road obliteration program is its on-the-ground techniques and practice of revising obliteration methods to improve effectiveness.

- Recent changes in methods include: a) use of a more appropriate grass mixture with less aggressive grass species, b) more use of native transplants, c) more topsoil preserved for the new surface, and d) less focus on planting container trees in more recent obliteration efforts.
- We recommend future research to determine the effectiveness of different levels and types of mulching on the obliterated roads.

Prioritizing Roads for Removal

- The main weakness of the road removal program on the CNF is its prioritization of roads and watersheds for road obliteration and in its maintaining road densities greater than 1mi/mi2 after obliteration.
- Currently the CNF is concentrating its obliteration efforts in watersheds with high road densities.
- According to Frissel (2001) the greatest benefit to fisheries and wildlife would be gained by focusing obliteration efforts on watersheds that still have low road densities and/or critical habitat for aquatic and terrestrial species.
- Watersheds still largely intact, with high quality habitat and a large diversity of wildlife should be given first priority (Bagley 1998).
- Efforts should focus on restoring large areas to a roadless condition by obliterating roads that bisect otherwise roadless areas and focusing on watersheds that border roadless areas or are part of large migration corridors for terrestrial wildlife.

Key Conclusions:

Obliteration programs will be more ecologically beneficial when ecological considerations are given at least as much emphasis as resource use and management, and when achievement of obliteration programs is measured by the land area restored to densities less than one mile per square mile as well as by the miles of road obliterated. Until the Forest Service is willing make this shift, obliteration efforts are likely to follow the current trend of focusing on heavily roaded areas, obliterating more miles of road over a smaller area and spending more money for less ecological benefit.

Contribution and relevance to conservation in the Yellowstone to Yukon region:

The results of this study will be useful in efforts to protect and restore wildland ecosystems in the Y2Y region. Groups and individuals within Y2Y will utilize the results to analyze the effectiveness of all road closure and restoration projects on public lands. We must work for effective road closure if we hope to see an interconnected wildlands system of large core areas and secure corridors for wildlife, and the results of this study will provide one tool to help us realize that vision.

WILDLIFE USE IN RELATION TO STRUCTURE VARIABLES FOR A SAMPLING OF BRIDGES AND CULVERTS UNDER I-90 BETWEEN ALBERTON AND ST. REGIS, MONTANA

Principal Investigators: Christopher Servheen, School of Forestry, University of Montana; Rebecca Shoemaker School of Forestry, University of Montana; Lisa Lawrence, School of Forestry, University of Montana;

Partnering Organization: American Wildlands

2002

Purpose and background

Habitat fragmentation, habitat loss, and human caused mortality are the major factors contributing to wildlife decline throughout the world. High speed, heavily used highways can often divide formerly contiguous blocks of habitat and wildlife populations. Highways can also reduce important seasonal habitats. Healthy populations may be maintained if there is adequate movement between them. Highways and human development often limit such movement.

Linkage zones are defined as combinations of landscape structures that allow wildlife to move through and live within areas influenced by human actions, and their effectiveness relies largely on the level and types of human actions as well as the biology of the animal (Servheen et al. 2002). Effective linkage zones may combat the adverse effects of habitat fragmentation by allowing opportunity for movement between populations. Several linkage zones have been identified across Interstate 90 (I-90) in western Montana that could potentially link wildlife populations on both sides of the highway, including wolves, lynx, black bears, wolverines, and possibly grizzly bears (Servheen et al. 2002). Crossing a highway can be accomplished either by walking directly over the roadway or by utilizing existing structures under the roadway such as culverts or underpasses. This project is aimed at understanding the movements of medium to large wildlife species through the existing underpasses and culverts under a portion of I-90.

Objectives

- Record wildlife use of a sample of underpasses and culverts along I-90 using infrared, motion sensitive 35mm cameras and snow tracking.
- Document multiple variables associated with each underpasses and culvert.
- Correlate structure variables, human use, traffic volume and time of day with the type and frequency of wildlife use.

Study area

The study area is an 80 km stretch of I-90, west of Missoula, Montana. This is a four-lane highway, which follows the Clark Fork river valley and experiences a traffic volume of roughly 6500 vehicles per 24 hours. There are numerous other paved and unpaved roads in the area as well as a railroad and a river, which parallel the highway. Although the valley bottom is experiencing human population growth and development, the majority of the surrounding, mountainous land is public. Four wildlife linkage zones (Servheen et al. 2001) have been identified in the area and three of the four linkage zones had suitable structures for monitoring.

Methods

Landscape features documented for each structure include distance to hiding cover and surrounding topography; structural dimensions such as length, width, and height of each bridge or culvert; and human influence including human population density, type of human activity, and road density. Distance to adequate hiding cover from the entrance to each structure and percent cover was also determined.

We used heat and motion sensitive cameras to monitor a sample of underpasses and culverts within the study area. Each wildlife-crossing photo was assigned a time category of day, night, or dawn/dusk. Each structure was monitored with infrared cameras and snow tracking through March 31, 2003. Each structure was given a species use index rating based on monitoring data.

Results

Underpasses spanned either the Clark Fork River, Montana Rail Link railroad tracks or paved roads and were usually large, open structures. Culvert size ranged from 2 m to 4.6 m in diameter. Wildlife trails indicated consistent crossing of the interstate via most underpasses, at least for deer. Trails often ran parallel to I-90 until the trail passed under the highway via the structure. Wildlife use of structures was most frequent in underpasses and limited in culverts. Species documented to use structures included white tailed deer, elk, skunks, raccoons and domestic cats. Our study season was limited to late fall and winter, when bears are hibernating.

Key conclusions

Our findings indicate that even large culverts may not be effective structures for movement of large and medium size mammals, probably due the lack of surface substrate inside. Continuity of the natural habitat on either side of the structure, and under bridges, when possible, is important and increases the probability of wildlife use of underpasses. Structure openness was high at underpasses we monitored and may be the contributing factor to wildlife use. Levels of deer use of structures may be a somewhat a response to seasonal movements (fall migration, hunting pressures, and breeding), which may inflate assumed yearly use. Highway mortality of wolves, coyotes, and black bears was documented in our study area. Future studies should extend through seasons when bears are active.

Relevance to regional connectivity

Highways may be significant fragmentation factors for wildlife. The development of many special highway crossing structures for wildlife is unlikely due to high costs and disruption to highways during construction. Understanding factors associated with wildlife use of existing structures will provide information for minor modifications to maximize their utility to wildlife with minimal investment.

Literature Cited

Servheen, C., J. Waller and P. Sandstrom. 2001. Identification and management of linkage zones for grizzly bears between the large blocks of public land in the northern Rocky Mountains. U.S. Fish and Wildlife Service, Missoula, Montana. 87 pp.

BIODIVERSITY SURVEY IN THE WOLF LAKE ECOSYSTEM, YUKON TERRITORY, CANADA

Principle Investigators: Dave Mossop with Researchers (1999. Nisutlin Lake, Wolf River and Morris Lake); Alejandro Frid, Rhonda Rosie, Brian Slough, Bruce Bennett, Dave Jones, Marty Strachan, Dennis Kuch, Larry Gray (2000 Red River Lake and Crescent Lake); Rhonda Rosie, Brian Slough, Rem Ricks, Dennis Kuch, Larry Gray. Project Coordinator and Mapping: Randi Mulder, CPAWS-Yukon; Project Manager: Juri Peepre, CPAWS-Yukon

Partnering Organization: CPAWS - Yukon

1999

The research in the Wolf Lake ecosystem was conducted in collaboration with the Teslin Tlingit First Nation and the Teslin Renewable Resources Council. First Nations members, representing the First Nation and the Renewable Resources Council, participated on the research trips. We were especially fortunate to have the participation of respected elders, who described traditional ecological knowledge.

Purpose and Objectives

The Wolf Lake ecosystem is one of the largest intact predator-prey ecosystems in the southern part of the Yukon within the Y2Y region. In support of land use planning and conservation proposals in the area, the Canadian Parks and Wilderness Society - Yukon Chapter (CPAWS) organized a series of reconnaissance biodiversity surveys in the region between 1998 and 2000. Previous researchers had identified the Wolf Lake ecosystem as one of the most diverse and productive in the southern Yukon, but the work had focused mainly on large ungulates.

The objectives of the various surveys were to:

- learn more about vegetation communities and species occurrence;
- establish a number of vegetation plots to support future vegetation cover mapping;
- observe and record bird species habitat and occurrence;
- observe and record small mammal species, including bats;
- observe and record amphibians; determine presence of fish and extent of populations;
- examine caribou and moose habitat, and extent of use;
- examine signs of predator presence and assess large carnivore habitat availability;
- learn more about traditional interpretations of the flora and fauna in the region;
- photograph the landscape and prepare a series of maps to depict conservation values in the ecosystem
- raise awareness of the region's natural features in the community and the Territory as a whole.

Methods

The biodiversity surveys took place over three seasons with multi-disciplinary teams of scientists and local knowledgeable people visiting five different sites in the ecosystem. The research focused on presence and absence of terrestrial, avian and aquatic species, and on habitat availability and use by species. Survey techniques included vegetation surveys, including plot sampling, collecting and identification of community types; wetland habitat assessment; small mammal live trapping; bat surveys using ultrasonic detectors; ungulate habitat assessments using fecal pellet-group transects; observations on predator use of the region; fish surveys using gill netting, minnow traps, angling and observation; bird point counts and observations of breeding and migratory birds.

Selected Principal Results

Three research reports describing the findings of each survey were produced for each of the summers that the field work took place, followed by an atlas of conservation values that synthesized the results.

Birds

- A total of 102 species of birds were observed on the research trips in the Wolf Lake ecosystem, ranging from waterfowl, to owls, to songbirds. A further 27 species are suspected to occur here. Of the species observed, 15 were confirmed breeders in the region.
- The mix of wetlands, dry and wet boreal forest, ponds and larger lakes provides a good variety of bird habitats. The frequent observance of top-of-the-food-chain predators suggests this is a diverse bird community and ecosystem. Bald Eagles were abundant along the Wolf River, indicating a highly productive aquatic ecosystem.

Large Mammals

- Moose are abundant in the wetlands surrounding Wolf Lake. They use the Wolf River extensively and were frequently seen by the research crew that canoed down this river.
- Caribou appeared to use the spruce-dominated habitat surrounding mainly during winter and fall while using the pine-dominated habitats during the summer.

Small Mammals

- Night time bat calls were recorded in the wetlands at the mouth of Trout Creek, at Wolf Lake. These are Little Brown Bats.
- Night time bat calls were also recorded in various habitats near Morris Lake. Up to 158 calls and seven foraging buzzes were taped in one night. These included calls from the Little Brown Bat and what appears to be the Big Brown Bat. The Big Brown Bat had not previously been recorded in the Yukon.

Fish

- The mainstream Wolf River has a great deal of suitable habitat for Chinook spawning. The Wolf River system also supports productive populations of lake trout, whitefish, arctic grayling, northern pike and suckers. Excellent Chinook salmon spawning habitat was observed at the outlet of Nisutlin Lake.

Vegetation

- As a result of vegetation surveys on all the field trips, a total of 343 different vascular plant species (from 52 different families) were recorded in the Wolf Lake region. Several of these had not previously been known to occur in the area, sometimes extending the known range of the species considerably.
- Of the vascular plant species identified, 25 are considered rare in the Yukon. Rare plants were discovered at each of the main research sites.
- 30 different moss species and 60 different lichen species were recorded on all the field trips combined.

Key Conclusions

These reconnaissance biodiversity surveys confirmed the larger mammal species richness and abundance in the ecosystem described by others; provided new data on vegetation communities, fish habitat and species, breeding and migratory birds; added species previously unknown in the Yukon (Big brown bat); confirmed the presence of rare plants, and provided an improved understanding of the diversity and importance of conservation values inherent in the Wolf Lake ecosystem.

Research Relevance to Yellowstone to Yukon

This research confirmed the importance of conservation of the Wolf Lake ecosystem within the northern part of the Y2Y region, as an example of a low and medium elevation landscape, characterized by an intact woodland caribou range, important wetlands and aquatic habitat supporting spawning grounds at the headwaters of the longest salmon run in the world. The atlas of conservation values will be a useful tool in further conservation planning in the region.

AND MORE...

CONSERVATION OF LONG-TOED SALAMANDERS IN ALBERTA'S FOOTHILLS

Principal Investigators: Lisa Wilkinson, Alberta Fish and Wildlife Division; Cal McLeod, Stephen Hanus & Selwyn Rose, Alberta Conservation Association.

Partnering Organization: Alberta Conservation Association

2002

Background

Historic migration of long-toed salamanders along the Rocky Mountain foothills has brought them to the limits of their current range. They are a species of "special concern" in Alberta because their populations are isolated and discontinuous, they appear to be vulnerable to habitat disturbance, and populations may be declining. Long-toed salamanders are small, cryptic, and nocturnal. They dwell in forests for most of the year, except during spring when adults travel to ponds to breed. Eggs hatch within three weeks, and larvae metamorphose at the end of the summer, at which time they leave the pond and disperse into the forest. Initial population surveys were conducted in 1995 in Jasper National Park and the Oldman River Basin area. We have established two long-term monitoring areas are in the Bow (Kananaskis country and area) and Athabasca (Hinton area) Valleys. Amphibian monitoring began in these areas in 1997 and 2000, respectively, although the focus on long-toed salamanders did not begin until 2001.

Purpose and Objectives

The impact of habitat fragmentation, particularly in light of increasing industrial development, settlement, and recreation in the Alberta foothills, could exacerbate the vulnerability of these already isolated salamander populations. There is recent evidence that clearcutting can negatively impact long-toed salamanders. Large scale oil and gas exploration removes considerable forest volume and is occurring at an accelerated rate.

We initiated a long-term salamander monitoring program to understand population distribution and trends, and to ensure that critical habitat is protected. We are increasing efforts to more accurately identify distribution and habitat needs, and assess the potential impacts of habitat fragmentation on salamander populations. In light of global amphibian declines, long-term monitoring and conservation are necessary; conserving critical wetland and forest habitat benefits a number of species. Education is also an integral component of this program.

Methods

In each study area, known long-toed salamander breeding ponds were surveyed in May to search for presence of eggs and/or adults, and in some locations, ponds were surveyed for presence of larvae in June and July. New ponds were also surveyed in each study area, as well as surveying selected areas between Athabasca and Bow valleys to identify new populations. We also revisited ponds in Jasper National Park to determine persistence of populations. A number of environmental conditions and general habitat characteristics were recorded for all ponds. In addition to surveys, one pond in each study area was encircled by drift fencing and pitfall traps designed to capture all amphibians travelling to and from breeding ponds. Traps were operated from May to early June, when adults travel to ponds to breed, and from August to early October, when young salamanders emerge from ponds to disperse. Traps were checked regularly, and we collected data on length, mass, sex, and general health, before releasing salamanders on the opposite of the fence from which they were captured. The number of salamanders captured can be compared between years as an indication of local population trends. At the Athabasca site, salamanders were injected with a non-toxic, long lasting latex at the base of the tail (it appears as a small coloured dot) which serves as a unique marker. Being able to identify previously captured individuals increases our ability to determine population size and changes over time.

Results

We were not able to locate any new long-toed salamander populations in 2002, and although further surveys are needed, this suggests that populations are extremely isolated. Ponds in both Jasper National Park and the Hinton area had high levels of long-toed salamander population persistence, although Hinton ponds have only been surveyed for two years. Salamander ponds in the Kananaskis area, which have been surveyed for up to five years, had only 56% persistence. The majority of these ponds are not in protected areas, underscoring the need for conservation measures. The number of adult long-toed salamanders caught in the Hinton pitfall traps was similar to 2001, and the number of young dispersing was greater than 2001. The Kananaskis pitfall trapping pond began operation in 2002, and there was a high abundance of adults and young salamanders. No deformities were observed. Wood frogs and boreal toads were also captured, and spotted frogs were observed at the Kananaskis pond. Educational presentations and displays reached approximately 4000 people.

Conclusions

Long-toed salamander populations appear to be stable in protected areas, however, recreational activities can have a negative impact on populations (i.e. trampling eggs along the shoreline) and ponds should be monitored accordingly. In areas where there is increasing pressure from industry and development, salamanders are at higher risk, as evidenced by the Kananaskis results. Where possible, we are designating protective buffers around breeding ponds. Improved policy is needed to prevent draining, contamination, and fish introduction at critical breeding ponds. Long-toed salamanders require terrestrial habitat with adequate moisture and cover, so we need to maintain areas of intact forest in breeding areas. Protecting key source populations will become increasingly important as habitat fragmentation and destruction escalates in the Alberta foothills. Continued monitoring and survey efforts are recommended.

Relevance to conservation in Y2Y region

It comes as a surprise to many people that amphibians live in the mountains and foothills, yet they are clearly an important component of the Y2Y ecosystem. Wetlands provide critical habitat to a suite of wildlife species, and educating the public about their importance is just as important as monitoring populations of species which may be at risk. Not only is this project integral to conserving long-toed salamanders, but it represents a collaborative effort towards research, education and conservation in the Y2Y region, and has the potential to benefit a number of species.

Acknowledgements: Funding was provided by the Y2Y Conservation Science Grants program, Alberta Conservation Association, Alberta Fish and Wildlife Division, and Weldwood of Canada Ltd. Sincere thanks to the many volunteers who participated.

THE INLAND RAINFOREST FORMATION OF NORTHWESTERN NORTH AMERICA: A LICHENOLOGICAL PERSPECTIVE

Principal Investigators: Trevor Goward, Enlichened Consulting Ltd., Clearwater, B.C. & Toby Spribille, Ecological Consultant, Fortine, MT and Göttingen, Germany

Partnering Organization: Global Forest Science, Banff, AB

2001

Purpose and objectives

The inland oldgrowth forests of south-eastern British Columbia are one of Canada's most endangered ecosystems. These forests occur in small pockets on the windward slopes of the Columbia and, to a lesser extent, the Rocky Mountains. Here rainfall is heavy, especially in early summer, and forests tend to persist for many centuries. Stands of large, old Western Red-cedar and Western Hemlock are common, with individual trees having been estimated at 700 years of age. Many of these stands, moreover, have been around much longer than the oldest living trees within them.

Despite the global significance of British Columbia's inland oldgrowth forests, little is known about their ecology, their geographic extent and their relationship to their coastal rainforest counterparts. In this project, supported by Global Forests, and funded by the Wilburforce Foundation, we attempted to provide a framework both for delimiting them, and for recognizing which of these forests have the most in common with coastal rainforests. More specifically, we used tree-dwelling macrolichens to assess the degree of environmental similarity between these inland rainforests and their coastal counterparts.

Lichens have no roots, and so satisfy their moisture requirements directly from the air, providing powerful indicators of regional climate. They also are well adapted to dispersing across great distances. This means that the absence of a given lichen species in a given forest is likely to reflect, not limitations of dispersal, but a lack of suitable climatic conditions. The same cannot be said of most shrubs and flowers, which have much heavier seeds than lichens do, and are comparatively less efficient at dispersing.

Methods

We mapped the distribution of over 90 macrolichen species with oceanic tendencies both on the coast and in inland regions. Total number of species was calculated for quadrats measuring 1° of longitude by 1° of latitude and densities of oceanic species were plotted for coastal and inland regions. Species densities by latitudinal belt were then regressed against climatic data from British Columbia, Idaho and Montana. This allowed us to compare densities of oceanic lichen species from coast to inland and examine correlations with major climatic factors (precipitation, temperature normals) along the gradient from north to south.

Principal Results

We found that nearly half of the oceanic macrolichen flora of northwestern North America occurs inland in the wettest portions of south-eastern British Columbia. In about a half dozen valleys, these lichens occurred in numbers high enough to suggest that the forests supporting them are true rainforests. Along the latitudinal gradient, summer precipitation decreases from north to south, while summer temperatures increase, resulting in a summer deficit in even the wettest cedar-hemlock habitats south of 51°N. This summer moisture deficit appears limiting to the occurrence of lichens with rainforest affinities.

Key conclusions

The mapping of oceanic lichen densities allowed us to map British Columbia's inland rainforests as forming a discontinuous band from the Robson Valley east of Prince George, at 54°N, to the northern end of Duncan Lake southeast of Revelstoke, at about 51°N. South of 51°N, summers are apparently too dry to support most oceanic lichens; these moist temperate forests must be regarded as largely peripheral to the inland rainforest formation. A few southern outliers have also been reported, but more work is needed to confirm their rainforest status.

Relevance to conservation in Y2Y

After many decades of industrial logging, the inland oldgrowth rainforests of British Columbia are much reduced compared to their original extent. How many hectares remain is unknown, but it is certain that very little is left, especially at lower, valley-bottom elevations, where the biggest, oldest trees once grew.

The identification and mapping of rare ecosystems is a cornerstone to on-the-ground conservation efforts. The present project has provided a more differentiated definition of one of Canada's most rare ecosystems: the inland temperate rainforests of inland British Columbia. This ecosystem is a hitherto little recognized but integral part of the Yellowstone to Yukon region. The presentation of hard evidence on high oceanic lichen densities in inland oldgrowth forests has already been used to demonstrate the rare and unique status of these ecosystems and gain protection for ancient forests slated for further industrial logging.

DISPERSAL AND POPULATION PERSISTENCE IN THE ALPINE DWELLING HOARY MARMOT

Principal Investigators: David Hik, Tim Karels, Gerda Ludwig and Christine Cleghorn, Department of Biological Sciences, University of Alberta, Centre for Biodiversity Research, University of British Columbia, Yukon Conservation Society

Partnering Organization: Yukon Conservation Society

2002

Purpose and Objectives of the Research

Alpine dwelling hoary marmots (Marmota caligata) may be a suitable indicator species for assessing alpine ecosystem integrity and alpine connectivity within the Yellowstone to Yukon corridor. We used demographic data from live-capture, radio-telemetry, genetic and modeling studies to examine the role of dispersal and landscape connectivity for regional persistence of hoary marmots. We also developed a non-intensive method for estimating local marmot abundance that can be carried out by non-specialists in order to establish a regional marmot-monitoring network to assess impacts of changes in landscape and climate variability.

Methods

The study site is a 4 km² alpine valley (1700 m a.s.l) in the Ruby Ranges, near Kluane Lake, Yukon (61°N 138°W). Hoary marmots are currently the most abundant herbivore in the study area, which include collared pikas, arctic ground squirrels, ptarmigan, voles, Dall sheep, caribou, and grizzly bears. Marmots were live-captured using Tomahawk live-traps, and at each capture each individual was uniquely marked with numbered eartags, measured, and reproductive status determined. Tissue samples were taken from ear biopsies for DNA microsatellite analyses. Since 1999, we have captured 220 individuals from 10 social groups, including 136 juveniles have been captured from 37 individual litters. Forty marmots have also been implanted with radio transmitters and temperature loggers. Fecal pellet counts were conducted along 2-m 100-m transects located parallel to the edge of alpine boulderfields occupied by marmots. We also tested the stability of hoary marmot populations exposed to different climatic conditions by constructing a matrix based, non-spatial, two-sex population model. The model was based on three interacting social groups of different size (A>B>C), and dynamics were dependant on overwinter survival, reproduction, dispersal, immigration and emigration. Demographic variation was included by letting parameters randomly fluctuate within a set range. Environmental variation was included by making this range depend on condition in each year.

Principal Results

Demography: Reproduction in hoary marmots is sensitive to spring conditions, with reproductive rates of adult female marmots being higher in years with earlier snow melt. Delayed snowmelt was also associated with poor overwinter survival of juveniles born in that year. Juvenile survival was also dependent on group size and composition, with survival increased by 20% for every marmot in the social group that is 3 years of age or older.

Dispersal: In summer 2002, 10 of 11 potential dispersers remained in their social groups despite having reached reproductive maturity. None of these marmots reproduced in 2002. Overall, and rather unexpectedly, we have observed little evidence for long-distance dispersal.

Genetic structure of the population: Six distinct, and three moderately distinct subpopulation units were genetically identified, corroborating visual observations of social groups from 1999-2002. This differentiation persists despite a moderate level of home range overlap of dominant males that encompass the home ranges of all members of each social group. These findings are likely related to the intricate social system and dynamics of this species including mate selection that is greatly restricted to within the social group, recruitment of juveniles from their natal colony, reproductive suppression of subordinate individuals, and low levels of migration between groups.

Development of an index for estimating marmot abundance using fecal counts: Marmots spent 74% of their activities in meadows at a mean distance of 11.6m. Fecal counts at 10 m distant from the edge of talus were strongly and linearly related to marmot abundance ($r2 = 0.89$, $n = 14$, $P < 0.001$).

Model simulations: The hoary marmot population shows a great stability in different climatic conditions. Only when there were many years without reproduction, or when there was a strong influence of social group size on juvenile survival was the risk of extinction increased (> 0).

Key Conclusions

After four years of studying a population of hoary marmots in the Yukon we found that these animals are sensitive to small variation in annual weather conditions, particularly in spring. There is relatively little movement between different social groups, and this observation is supported by genetic analyses. Thus, isolated populations may not be connected to adjacent populations, increasing the potential risk of extinction. Future work will determine the extent to which these populations are isolated under natural conditions. Finally, we developed a robust and simple method for surveying the density of hoary marmots using fecal pellet counts in late summer, which could be adapted for regional survey of alpine marmot populations.

Contribution and relevance of the research findings to conservation in the Y2Y region

The results of this study indicate that alpine dwelling hoary marmots may be a suitable indicator species for assessing alpine ecosystem integrity and alpine connectivity within the Yellowstone to Yukon corridor. The study found that there is little movement between social groups, and little evidence of long-distance dispersal. This results in fairly isolated populations, which may have an increased risk of extinction. Thus alpine hoary marmots may be seen as a species that provides us with an early indication that habitat fragmentation thresholds are being exceeded, or, on the positive sign, an indication that sufficient connectivity is being maintained. The study also found that alpine hoary marmots are sensitive to small variations in annual weather conditions, especially in the spring. This means that they may be particularly susceptible to climate change. The importance of habitat connectivity could become even greater if climate change begins to exert a negative influence over birth rates and survival of juveniles. One of the most useful aspects of the study is that it verifies the correlation between fecal pellet abundance and marmot presence. This will enable specialists and non-specialists to cost effectively monitor the effects of activities like recreation, mining, and forestry on ecosystem connectivity.

AND MORE...

CROWN OF THE CONTINENT, TRANSBOUNDARY ECOREGION, CUMULATIVE EFFECTS ANALYSIS

Principal Investigator: Miistakis Institute for the Rockies

Partnering Organization: Miistakis Institute for the Rockies and CPAWS-BC

2000

Purpose and Objectives

The Castle and Flathead watersheds of Alberta, Montana and B.C. represent an international ecosystem of remarkable wilderness value. The region is currently facing an increase in human activity in terms of recreation and resource extraction. In order to maintain the ecological process and manage human presence sustainable within this landscape, land managers should make incremental developmental decisions within a regional cumulative effects framework.

Miistakis' broad objective was to highlight the usefulness to land managers and other interested parties of a CEA tool that could provide context for site-specific developments across jurisdictional boundaries. Our first goal was to acquire and process seamless spatial layers and gather additional data needed to run an established CEA model on the Flathead and Castle watersheds. For the CEA analysis Miistakis selected the Alberta Landscape Cumulative Effects Simulator (ALCES) designed by Brad Stelfox. ALCES enables the user to assess the effects of petroleum extraction, forestry activities, mining, recreation, grazing and developments on habitat and wildlife in our transboundary region.

Our secondary objective was to provide public interest groups with tools to highlight the significance of this region, thereby reinforcing the need to address CEA within this region. Given these objectives, this transboundary cumulative effects project has two linked products:

A. Cumulative effects GIS maps portraying the extent of human ownership, road/trail development, logging activity and petroleum exploration across the Castle and Flathead drainages and Waterton-Glacier International Peace Park. This product is designed to stimulate conversation on inter-jurisdictional management in the Crown of the Continent region. The maps were accompanied by a report documenting the source spatial data, processing methodology and assumptions made when the spatial files were cross-walked. The report included some preliminary calculations of initial land base developments. The maps were distributed to decision makers and ENGOs promoting the importance of the area.

B. A report on the transboundary application of ALCES, with pilot results, designed to provide a feasibility study and head start in establishing partners to acquire projection information for the human footprint to enable what if scenarios in ALCES. This report contains the entire initial land base results and is targeted towards decision-makers who would employ ALCES.

Methods

Miistakis employed A Landscape Cumulative Effects Simulator (ALCES), developed by Brad Stelfox of Forem Consulting Ltd (1999). ALCES is a quasi-spatial model that tracks both natural, and anthropogenic changes to the landscape over time. Anthropogenic landscape changes include those incurred by forestry, oil/gas, mineral development agriculture, and human settlement. Natural landscape changes come from fire, meteorological and hydrological processes, and vegetation growth and yield. Importantly, ALCES tracks the occurrence and quality of key wildlife indicator species on both the natural and anthropogenic land-base.

When the land-base for the CEA is initialized (using seamless GIS spatial layers), and the variables representing the features on the land-base are entered, ALCES provides managers with a powerful modeling tool with dynamic gaming features that tracks changes on the landscape over space and time. The strength of the model lies in its ability to reveal threats to the sustainability of ecological systems. Using What If Scenarios one can plan land-use strategies which minimize the undesirable consequences of co-occurring human landscapes.

Key Findings

Miistakis produced a set of complementary overlay maps to highlight the extent of human activity in the region. These seamless spatial layers were also used for theALCES initial land base component. However, information pertaining to human use projections (i.e. petroleum yield curves and future extractions) was difficult to obtain. As a result Miistakis spent much of it's time engaging stakeholders to become involved with ALCES. Through this process Miistakis has become the Secretariat of the Crown Mangers Partnership (CMP), a coalition of agencies seeking to maintain the Crown's ecological integrity and address the human demands on the Crown region through coordinated and collaborative research efforts. The partnership is facilitated through annual forums and a Steering Committee. The CMP has initiated a cumulative effects assessment, using ALCES, for the Crown of the Continent region.

Relevance to Conservation in the Y2Y Region

This study was successful in that it led to the development of spatial layers required in modeling and cumulative effects analysis. Miistakis has also successfully engaged land managers to commit and initiate a CEA for the region. Miistakis provides secretariat support to the CMP effort and many of the layers developed for the Flathead and Castle Transboundary CEA are being incorporated into this process. In addition, the key spatial layers developed for this process have also been used to run CEA models for Grizzly Bear in the Flathead and Castle.

WILDLIFE, FISHERIES AND RECREATIONAL RESOURCE VALUES IN THE WOOD RIVER AREA OF THE COLUMBIA (GOLDEN) FOREST DISTRICT

Principal Investigator: Dennis L. Hamilton, RPBio., Nanuq Consulting

Partnering Organization: East Kootenay Environmental Society

1999

Project Area

The Wood River is located in the most northeastern portion of the Columbia forest district. It is bordered to the west by the Kinbasket Reservoir, to the east by Hamber Provincial Park and separates the Hooker and Clemenceau Icefields to the northeast and southeast respectively. The Wood River itself is characterized by a wide, relatively shallow river system with multiple braided channels and extensive depositional zones that drain through the Wood Arm into the Kinbasket Reservoir, which resulted from construction of the Mica Dam in 1973. Access is limited to helicopter or boat, with vehicular access requiring permission to use forest licensee's ferry.

The area is located mostly in the Central Park Ranges ecosection with a portion along the Kinbasket Reservoir within the Big Bend Trench ecosection. The Interior Cedar-Hemlock, Englemann Spruce-Subalpine Fir (ESSF) and Alpine tundra biogeoclimatic zones are characterized by cool, wet winters and warm dry summers. Hamber Park, at the headwaters of the Wood River, supports the damp, cool ESSFdk biogeoclimatic subzone - which is not found elsewhere in the Golden area.

Purpose

At the request of the East Kootenay Environmental Society, a project was initiated to identify and document wildlife, fisheries and other resource values for consideration in managing the relatively remote Wood River area as a Special Resource Management Zone (SRMZ) under designation of the Kootenay-Boundary Land Use Plan Implementation Strategy (1996).

Objectives

- The project objectives were:
- To review existing wildlife resource inventories and information;
- To conduct interviews with biologists, researchers, resource planners and other individuals with resource knowledge of the area; and,
- To report and, where applicable, map findings.

Methods

Ecosystem, wildlife, fisheries and recreation inventory was gathered specific to the project area. Interviews were conducted with naturalists, biologists, researchers and local individuals with knowledge of the area. A reconnaissance-level field survey was conducted and results recorded. All information was then compiled, collated and reported.

Results

The project area is represented by Natural Disturbance Type (NDT) 1 (ecosystems with rare stand-initiating events), NDT 2 (ecosystems with infrequent stand-initiating events) and NDT 5 (alpine tundra and subalpine parkland). In contrast to the upper Wood River which is predominately alpine tundra parkland, the lower Wood River and Wood Arm is composed of mostly mature and old cedar-hemlock and fir-spruce forest stands.

The mountain caribou, Northern goshawk, American Peregrine falcon, Northern long-eared myotis and Northern Leopard frog are provincially designated as red-listed species (threatened or endangered) potentially present within the ecosystem units of the project area. In addition, 13 blue-listed species (sensitive or vulnerable) and 69 yellow-listed species (management emphasis) have been identified (Conservation Data Centre). Bindernagel (1991) observed classified 24 moose in the Wood River and Wood Arm, including one moose kill "attended by many wolves". An aerial survey of the Cummins River, south of the Bush River, by Brown (1990) reported 9 moose, tracks of wolverine, marten, snowshoe hare, porcupine and mountain goat.

A reconnaissance (1:20,000) fish and fish habitat inventory of tributaries to the Kinbasket Reservoir, including the Wood River and its tributaries, was conducted in fall of 1997 (Boag 1998). Kokanee salmon, eastern brook trout, bull trout, mountain whitefish and slimy sculpin were encountered. The importance of kokanee as a food source to Bald eagles and grizzly and black bears was noted.

Recreational access to the Wood River area is limited. The upper Wood River is accessible by foot from either Fortress Lake or Jasper National Park; however neither route is developed throughout its length. Historically, the trade route followed the Columbia River to Wood River and then through Jeffrey/Pacific Creeks to the Athabasca Pass. W.A. Moberley and David Thompson are names analogous with the route during the 1800s. The area supports spectacular scenery, including Mount Clemenceau (the 4th highest peak in the Rocky Mountains), the Clemenceau and Hooker Icefields and a sense of coastal-like wilderness and remoteness not found elsewhere in the southern interior Rocky Mountains.

Forest resource planning and development continue in the Wood River drainage.

Conclusion: Contribution to Yellowstone to Yukon region

The significance of ecosystem diversity, remoteness and conservation values supported by the Wood River area must be acknowledged. The Wood River provides a connection from Jasper Park on the east slope of the Rocky Mountains through Hamber Provincial Park and the Wood River to the Columbia River system on the west slope of the Rocky Mountains. The historic Athabasca Pass Trail (Wood River/Pacific Creek/Jeffrey Creek), Fortress Lake (Hamber Provincial Park), extensive Icefields (Hooker, Clemenceau and Columbia), the coastal-like climate and associated flora and fauna, rugged spectacular mountains and scenery, abundantly rich and lush riparian and alpine meadows and remoteness from settlement collectively contribute to make the Wood River a unique and special place.

D. MAKING CHANGE IN Y2Y

1. SCIENCE, ADVOCACY AND CONSERVATION

> *"Today few knowledgeable people would contend that our environmental decisions are too much dominated by neutral scientific expertise and do not reflect enough politics."*
>
> *—"Making Change" Session Chair Dr. Tim Clark*

MAKING CHANGE IN Y2Y: FROM SCIENCE TO CONSERVATION ACTION - PLENARY SESSION

Remarks: Dr. Tim Clark, Yale University, Northern Rockies Conservation Cooperative

Presentations:

From Afterthought to Planning Principle:
Mapping the Route to Connectivity in Banff National Park
Mike McIvor, Bow Valley Naturalists
Tony Clevenger, University of Calgary
Danah Duke, Miistakis Institute for the Rockies

Science and Conservation Planning across Scales in the Crowsnest Pass Region
Clayton Apps, Wildlife Conservation Society
Larry Simpson, Nature Conservancy Canada
Cheryl Chetkiewicz, University of Alberta

The Role of Partnerships for Conserving Grizzly Bears on Private Lands:
a Perspective from the Field
Seth Wilson, University of Montana

Science has an important role to play in conservation: It can identify issues that require our attention, inform debate over options for addressing them by predicting the effects of these various options and, in so doing, guide us in selecting among them. But in order for science to play these roles it must be seen by land managers, policy makers and the public as a tool that is worthy of attention and relevant to decision-making processes. As "Making Change" session chair Dr. Tim Clark's comment above suggests, this is often not the case in environmental policy or management processes today. Scientific information more commonly tends to be seen as simply one input among many, and one that is easily overshadowed by those of human values or prospective votes.

This realization presents conservation scientists and advocates alike with a significant challenge: How do we ensure (or at least increase the chances) that the information generated by science to inform our understanding of a particular conservation issue is both fully considered and reflected in the decisions that are made to address them?

In his opening remarks for the "Making Change" plenary session, Dr. Clark outlined the dimensions of this challenge and went on to contend that, in order to effectively address it, we need to do a much better job of making science relevant or useful for policy. Three important ways to do this are by:

- Placing more emphasis on the social aspects of the problems we face.
- Using common language that is understandable to citizens and stakeholders.
- Localizing or 'contextualizing' science so that it is relevant to specific stakeholders and geographies.

The "Making Change" plenary session at the symposium presented three examples or case studies of scientific research that have succeeded in (or promise to be successful in) positively influencing wildlife or land use policy, management or planning outcomes.

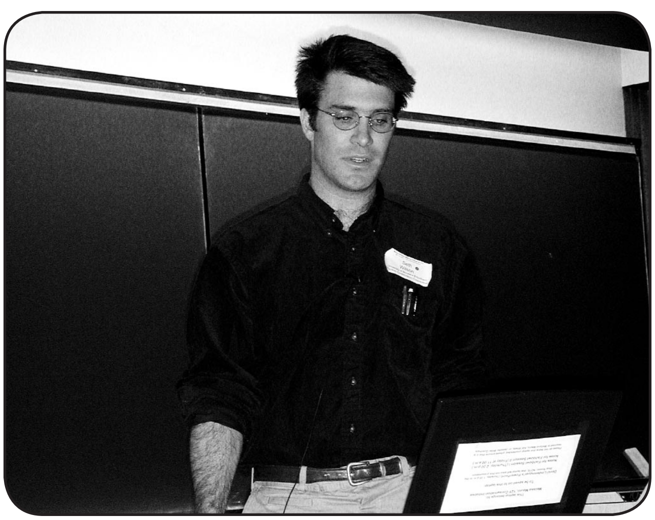
From the Bow Valley of Banff National Park, Mike McIvor, Tony Clevenger and Danah Duke described how ecological connectivity has emerged in recent years to take its place as an important principle guiding park planning. Within this context of public lands and protected areas, scientific research into wildlife corridors and wildlife movements in relation to the TransCanada Highway has been directly supported by Banff National Park. Local conservation organizations have been effective in keeping ecological connectivity on the planning and management agendas and in acting as 'watch dogs' that persistently encourage the Park to employ information from scientific research in making policy and management decisions.

Shifting jurisdictional emphasis away from parks to the public/private matrix lands of the Crowsnest Pass in south western Alberta, Clayton Apps, Larry Simpson and Cheryl Chetkiewicz described the myriad of threats to connectivity for large carnivore species in the region. The team's presentation showed how these threats have arisen as a result of rapid, uncoordinated growth across the jurisdictional matrix. They emphasized the urgent need for integrated planning that takes into account the requirements of large carnivores at local and regional scales, and described how information from two on-going carnivore movement studies - one at the regional and the other at a nested, local scale - are producing information that can feed directly into the planning processes of their provincial government and NGO partners.

Moving further south to Montana's Rocky Mountain Front, Seth Wilson picked up and expanded upon the

theme of partnership by describing the importance of partnerships to his research on human-grizzly bear conflicts on private, agricultural lands in the region. In a setting where: 1) private landowners are the de facto managers of their lands and thus, directly influence the wildlife who use it; 2) public agencies are mandated to conserve endangered species, including where they occur on private lands; 3) conservation NGOs have very strong interests in endangered species and other environmental concerns; and 4) all three groups have valuable information or resources to contribute to research and management. Engaging in partnerships at multiple levels and at various stages of the research process was pivotal to successfully conducting the study and in bringing about conservation opportunities informed by its findings.

These examples illustrate some of the ways in which the principles of relevant science outlined by Dr. Clark can play out in the 'real world' of research and environmental decision-making. They match the scale of research to the scale at which decision-making or management processes occur, and conduct research in partnerships. Each of these are effective approaches to making science relevant.



Moreover, it is clear from these examples that there are important roles for both conservation scientists and advocates to play in shaping research and applying it. Each offers distinct biological and social perspectives that help to elucidate context and formulate salient research questions, each brings expertise to bear in creating effective conservation tools, and each contributes to the process of translating and presenting the findings of science in ways that are meaningful to participants in the decision-making process.

As the work of the grantees and energy of the symposium event demonstrated, there is substantial interest among science and advocacy circles in the Y2Y region in forging partnerships to work toward common conservation objectives. To encourage the growth of successful partnerships, this plenary session and the fishbowls provided scientists and advocates fora to explore and better appreciate each other's roles on the conservation stage.

2. OUT OF THE FISHBOWLS... AND INTO THE FIRE:

Translating a Discussion Between Scientists and Conservation Advocates

I. INTRODUCTION

The fishbowls at “Making Science, Making Change” were oriented towards sharing the diversity of experiences of both scientists and advocates within science-advocacy partnerships. Our goal was to strengthen these partnerships by encouraging better understanding of the respective professional spheres in which research and advocacy is done, and the ways that we can reach across boundaries and move together into the “fire” of conservation efforts in the larger Y2Y context.

The fishbowls were designed to explore some of the critical issues confronting:

- Scientists whose research influences conservation advocacy work
- Advocates who use scientific research to advance a conservation goal

The discussions brought together symposium participants - scientists, advocates and others - to explore the worlds of science and advocacy as experienced by them, and the benefits and challenges that arise when these worlds come together.

Based on five years of funding partnerships between researchers and advocates through the Y2Y Conservation Science Grants program, we have learned that significant challenges exist around communicating science well and using science in the most effective, appropriate and strategic ways to advance conservation efforts. We also have learned that expectations and perceptions of one another’s roles in conservation can sometimes constitute ‘sticking points’ or obstacles to effective science-advocacy partnerships.

The first fishbowl, “Joy, Complexity, and Rigor,” addressed the challenges of “Making Science”. The second, “Passion, Policy, and Practice,” addressed “Making Change”. Open-ended questions in both sessions (the same questions for each of the three concurrent discussions) were designed to get at the motivations of participants for doing research or advocacy; the qualities of good science and good advocacy; and the challenges and opportunities that are created when the two intersect. In particular, we wanted to give scientists and advocates a chance to communicate to one another what they ***most*** wanted the other “community” to know about the opportunities and challenges of “making science” or “making change”.

The following synopsis captures patterns, common themes and some contradictory views, while also drawing conclusions and offering recommendations to improve the science-advocacy link. Some generalizations have been made; we hope they remain true to the spirit of the original discussions. A number of compelling and illustrative quotes taken directly from the discussion notes are also included.

II. FINDINGS ABOUT THE ROLE OF SCIENCE IN ADVOCACY

Scientists in the first fishbowl particularly expressed the need to let science speak for itself. They were eager for advocates to: 1) recognize both the exciting opportunity that science provides for knowing more about the natural world, and 2) understand the limitations of science when used to advance advocacy. Douglas Chadwick has called science "an organized form of wonder," and scientists in the fishbowl clearly expressed excitement about their research and the process of discovery. They also expressed concern that science is sometimes asked to carry too great a burden by advocates, or that it may be used to fulfill objectives to which it is not appropriately suited.

A. What can science do for advocacy?

Participants recognized that science often plays a critical role in conservation advocacy efforts, helping to identify new or emerging issues, set priorities and convince decision-makers. Science's "neutrality" and objectivity can help when value systems are clashing or emotions are running high. Science acts as a common language (one participant called it our "lingua franca") within the environmental community, to resolve internal disputes about priorities and gain cohesion.

"Without science, we wouldn't even know where to focus the work."

Science is an important legal tool, especially in the U.S., and it can also be influential with agencies and politicians, although some scientists and advocates disagree about the degree to which science can sway decision-makers. Other participants identified science as an important tool in helping to move an issue that has reached an impasse - to get "un-stuck".

"…because when you bring in well-done science, people can't ignore it."

B. What are science's limitations?

Many people in the symposium fishbowls - scientists in particular - pointed out the frequent confusing or conflating of science and values, and emphasized the need to separate them and identify each one's roles and strategic purpose. The rationale was that there are issues (and audiences) for which values are the most compelling arguments, and others where science makes the most convincing case for conservation.

"Science tells me how the world is, but not how it ought to be…."

"Science has never moved an agenda alone; advocates have."

"Science is critical, but not sufficient, as Tim Clark said. As a corollary, science doesn't always need to enter the equation. It should be complementary."

"As a society, we are looking to science to answer questions that are fundamentally moral questions."

"Science doesn't give one values, but most scientists and most research have implicit values."

"Objectivity…means that the values should affect the questions but not the WAY they are answered."

"We began by arguing for wilderness as a great wild place. Arguments have now evolved to be all about science – how can we get back to those good old arguments about the overall non-scientific appeal of wilderness?"

"[We need to advance] the precautionary principle: keep our hands off it. We don't always need science to make that argument."

"Some advocacy questions are philosophy questions, not science questions."

III. NOTABLE CONTRADICTIONS IN THE DISCUSSIONS

Some of what we heard from scientists and advocates about the characteristics of good science and good advocacy was almost directly contradictory – revealing some of the critical 'sticking points' that each group needs to be aware of when engaging the other in collaborative work on conservation issues. Many of these characteristics are so deeply imbedded in the science and advocacy fields that they have become invisible or un-stated – yet firmly established practices. They simply ARE the framework in which our respective work is done. The emergence of these contradictions in the fishbowl discussions illuminates the challenges that can be encountered in collaborative research-advocacy efforts.

A. Time Frames

Scientists need time to incubate ideas, develop projects, gather data and analyze results, and undergo a peer review process.

Advocates are often operating under conditions of urgency or with much shorter time-frames.

B. Culture of Complexity

Scientists operate within a framework that acknowledges the inherent complexity of research questions and answers, and of the intricate natural systems on which they are focused; they are trained to expect and embrace uncertainty.

Advocates must frequently provide science-based feedback on policy decisions that is clear, convincing about results, and that spells out the implications of a particular action; their training is to be influential and to manage uncertainty in their favor.

C. Communications

Scientists feel they need to communicate the complexity and uncertainty that characterizes scientific research as part of their message. Scientists are also trained to employ a highly specialized language to communicate within their professional community; their work does not often bring them into close contact, or require that they "connect," with people of diverse backgrounds or experiences for whom that language has little meaning.

Advocates are told by communications experts that they have limited space and a very abbreviated time frame in which to get their media message across to the "general public," and that messages for the general public should be constructed very simply and in basic terms. Advocates know that they need to continually broaden the constituency in support of conservation, and that to do this, they need to find ways to connect conservation messages with the values of their audience.

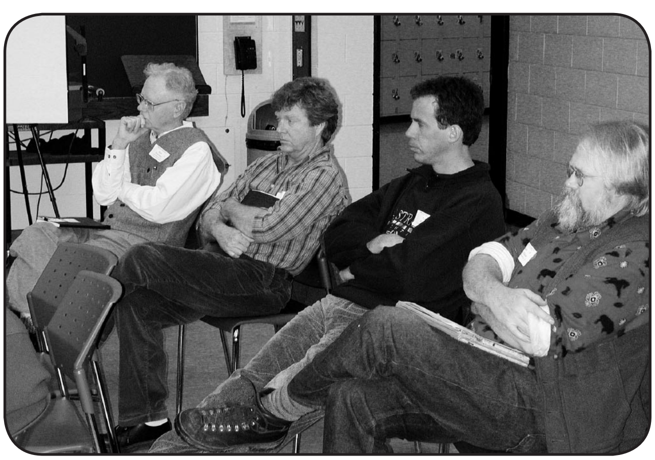
"Science cannot be converted into sound bytes: it distorts the science and distorts the message."

"Scientists don't know messaging. This ivory tower thing is great."

"There's a whole string of qualities that rules me [a researcher] out as the person who can take my message to the public."

"It's a scientist's job to educate. But look at who goes into science: social misfits who don't like other people, [who are] encouraged to work alone and be competitive rather than collaborative. We should be beaten with sticks until we straighten out."

The discussions illuminated the importance of being aware of the different modes of communication we need among scientists, between scientists and advocates, and between scientists/advocates and broader audiences. There are significant challenges in shifting modes of communication; for those of us who have worked hard professionally to develop facility in a professional language or with a particular audience, these shifts can be difficult.



IV. OTHER SIGNIFICANT THEMES

A. Professional Risk

Scientists bring credibility to a conservation debate, but there are often significant professional costs for doing so. For example, in pursuing or weighing in on research that may have policy implications, scientists often risk having their objectivity questioned by others within their professional community. Also, activities related to conservation policy and practice are not generally rewarded within the academic community, and science-advocacy partnerships take time and effort away from other activities for which professional credit or reward is more readily given. While there are a number of talented young and emerging researchers in conservation biology and in the Y2Y Network, there is a strong sense among many of them that they need to first establish credibility within the scientific community before being able to (more) safely branch out into a public policy realm. Even those scientists whose credentials and experience make them less vulnerable recognize that there is the danger of overexposure on conservation issues, or the danger that they will be perceived as increasingly driven by an agenda.

Another challenge faced by scientists is reconciling professional roles as scientists and personal roles as citizens. Some scientists expressed that they felt a duty as citizens to express values-based opinions about particular policy decisions, but that this kind of action needed to be separated from their professional function.

Meanwhile, advocates are continually in need of scientists for expert testimony or as alternative messengers. Researchers and advocates were in agreement that there are still too few scientists with the kind of professional standing that allows them to take bold stands on a variety of conservation issues.

"Scientists get in trouble with the scientific community for overstating. But understating gets you in trouble with the public."

"Scientists can become too political and start focusing on what they think might be achievable or possible."

"It's o.k. to state things, just be clear on where science ends and intuition begins."

"Doctors make decisions everyday based on insufficient data. Lawyers make decisions everyday based on insufficient data.You can make mistakes in honest judgment.We don't shoot doctors if they make wrong decisions."

B. Undermining of Science

Aside from the other challenges facing science and advocacy, the very relevance of science is being called into question, particularly under the current federal administration in the U.S. As politicians repeatedly ignore (or are unaware of) substantive, replicated, peer-reviewed findings – while sometimes intentionally elevate a single spurious study that bolsters their agenda – the question of whether science's "truth" will really carry the day is coming into sharp focus. Meanwhile, anti-conservation interests have also co-opted science by funding and producing studies that ask value-laden questions and arrive at the conclusion that resource development can be done without damaging environmental consequences.

In the absence of critical assessment and quality control of the research that holds sway in the policy arena, the erroneous belief that "science-is-science-is-science" or "all science is equal" further complicates our efforts to get high-quality research incorporated into policy decisions. As a partial response to this dilemma, scientists urged advocates to hold themselves to the same high scientific standards as they are held to within the science profession, and to let research speak for itself, without stretching its findings to meet an imposed advocacy agenda.

"There is a conscious attempt to undermine science. [This is] dangerous because if we lose the true value of science we're really screwed."

"Advocacy groups CAN have objective science, but sometimes they don't."

"We're stuck with the system that uses only the science that supports the decisions on the table and rejects the science that doesn't help."

"You won't find a single minister who has read a scientific article."

"There are a bunch of people who are anti-science; some people pretend to use science but they don't [really] comprehend science."

"A lot of things are masquerading as science that cannot be tested and rejected.These things are really philosophy, not science."

C. Funding challenges

Among participants, there was the perception that agency science may be limited by political agendas, and that university science is increasingly funded by corporate interests. Government research funding – particularly in the U.S. and particularly more recently – could run the risk of being awarded to serve the political needs of those with decision-making and appropriations authority. Advocacy organizations, though increasingly more frequent consumers – and now even producers – of science, also have value-implicit questions that they are asking and funding science to answer.

Scientists acknowledged that these conditions can sometimes pose significant challenges to or affect the direction of their work.

"Maybe science doesn't always ask the right questions because of the limitations of the system and the limitations of funding."

V. "BEST PRACTICES" FROM THE FISHBOWL

Based on participant feedback, an ideal melding of science and advocacy (for our purposes) would exhibit the following.

Research that:

- is peer reviewed
- follows the highest standards of scientific inquiry in research design and implementation
- is transparent about uncertainty and complexity (while minimizing them as much as possible and appropriate), but isn't eclipsed in a haze of caveats
- has the potential to be precedent setting or to change the political landscape
- arises from a relevant need diagnosed by the advocacy community, but whose questions and corresponding research methods are developed using high scientific standards.
- forecasts what is important and focuses on critical issues that are meaningful and pertinent (i.e., that abbreviates as much as possible the amount of time needed to perform good science)

Advocacy use and communication of science that:

- acknowledges uncertainty but persists in translating the implications of research findings into language that can be understood by the audience responsible for creating or demanding change
- includes possible solutions backed by the findings, so that science can help provide the positive "way out" and call to action on conservation problems
- doesn't elevate science to the exclusion of other values systems that can help persuade an audience (i.e., moral, aesthetic, spiritual arguments)

VI. RECOMMENDATIONS FOR STRENGTHENING SCIENCE-ADVOCACY PARTNERSHIPS

- Identify and understand the professional standards and constraints in which scientists and advocates must operate – what are our respective fishbowls?
- Acknowledge and respect the difficulties and limitations of working within scientific and advocacy frameworks, and fully appreciate the unique benefits that each can offer the other as actors on the conservation stage.
- Understand the big picture: economic and political context, feedback loops, how agencies function, how people get (or avoid getting) blacklisted.
- Identify and use the scientific information that is already available, rather than pressure researchers to expedite new findings.
- Identify and address the communications and dissemination challenges that confront science research itself and the use of science to bolster advocacy efforts.

> *"There needs to be a pact between scientists and advocates to be continuously educated by each other."*

VII. CONCLUSION

Thank you to everyone who participated in these fishbowl discussions. We, the conference organizers, believe this dialogue was an important opportunity to thoughtfully discuss some of the issues that lie at the heart of partnerships between scientists and advocates. The quality and candour of the exchanges, as well as the collegial spirit that prevailed, were good indicators of the extraordinary talent and passion of the scientists and advocates who have come together around the Y2Y science grants program. We appreciate working with all of you and look forward to continuing these conversations in years to come.

THE ROLE OF MENTORING

> *"You won't find wisdom on the web."*
>
> *– Mentoring Session Co-chair Ted Smith*
> *Kendall Foundation*

The complexity of today's conservation problems demands that conservation-minded scientists have not only the ability to investigate species and systems, but also to understand and navigate the broader societal context in which these problems arise and ultimately must be resolved. While formal scientific training succeeds in developing the specific skills of scientific inquiry and analysis, it is primarily by getting their feet wet that young scientists learn about the 'real world' of conservation and how to chart their own course through it.

The Yellowstone to Yukon Conservation Science Grants program supports the efforts of young scientists to ground their developing disciplinary expertise and professional practice within a conservation context. Each year, the program funds a number of research projects that are led by graduate students, working under the guidance of their academic supervisors, and in partnership with a conservation organization. Through this arrangement, students are provided with opportunities to 'push the envelope' of their professional experience such as presenting and defending their research to diverse audiences, or working with conservation or other organizations to translate their results for real-world applications.

Students also benefit by engaging with experienced colleagues who approach conservation problems from a range of disciplines that lie outside of the natural sciences. The informal tutorials they receive in sociology, economics, environmental ethics, policy sciences, or traditional ecological knowledge, compel students to expand the personal perspective from which they make sense of conservation problems and with which they explore avenues for most effectively contributing their own expertise.

The Yellowstone to Yukon Conservation Initiative and the Wilburforce Foundation view informal 'mentoring' opportunities such as these – where young professionals learn through practice and through relationships with more experienced colleagues – as a critical, but often overlooked, aspect of leadership within both the science and conservation non-profit professions.

To raise the profile of mentoring and to encourage its practice in the Y2Y region, a session at the symposium was devoted to discussing mentoring and its role in developing professionals and maintaining the health of our organizations. The session was led by co-chairs Dr. Mike Quinn (Faculty of Environmental Design, University of Calgary) and Ted Smith (Kendall Foundation). A synopsis of this discussion and web links to useful resources for current or prospective mentors and 'mentees' follows.

> *"We often lack good mentoring in the 'more with less' environment in which we work. This is an unfortunate irony because it is in such times when mentoring may be most important."*
>
> *– Mentoring Session Co-Chair Dr. Mike Quinn*
> *Faculty of Environmental Design, University of Calgary*

Mentoring is seen by many people in the Y2Y community as a critical tool for developing leadership and building healthy organizations. However, as session co-chair Dr. Mike Quinn observed, successful examples of mentoring can be hard to come by, particularly at times when resources are stretched across many competing and seemingly more urgent demands.

Given that creative leadership and strong organizations are themselves essential resources to have at our disposal in challenging times, why aren't we doing a better job of practicing mentoring? What are the barriers that stand in our way? And in light of these barriers, what actions can we take to make mentoring manifest within our scientific and conservation organizations?

These were the central questions posed by Dr. Quinn and co-chair Ted Smith (Kendall Foundation). In small groups, participants discussed these and other questions about mentoring and generated creative suggestions for encouraging the practice of mentoring within the science and conservation communities in Y2Y. This synopsis captures the key themes that emerged from the discussion and presents a summary of their suggestions as "10 things you can do to make mentoring happen within your own organization".

What is mentoring?

Mentoring is:

- When a trusted and experienced individual freely acts as a friend, advisor, coach, guide, teacher or role model to someone who is less experienced and in need of such a relationship.
- Associated with experiential learning and goes beyond the realm of knowledge or information transfer towards wisdom.
- About relationships. People skills and face-to-face contact are important contributors to successful mentoring.
- Not just for university students or interns – the person being mentored may be at various stages of their professional development. That said development stages that involve a transition from training to practice are times when mentoring may be most needed and most effective.

> *"The term mentor has its origins in Greek mythology and is associated with Athene, the goddess of wisdom. As mentor, Athene enacted the roles of father figure, teacher, role model, approachable counsellor, trusted advisor, challenger and encourager."*
>
> *"For me, mentoring is someone believing in you… just a little more than you do in yourself." Kingsford Jones, MS Candidate, MT State University*

Mentoring – It's not just for 'mentees'!

- The benefits of mentoring flow beyond the person being mentored to include the mentor and their organization(s).
- Mentoring helps to keep organizations healthy and dynamic. Dynamic organizations:
  - regularly bring in new people and help them to move through 'the system'
  - focus on developing and sharing new skills
  - encourage the development and sharing of wisdom – not just simple information transfer
- Mentoring also benefits future generations – *"We owe it to the next generation to bring along someone, ideally better than we are, to take our place."*

> *"Mentoring is not about cloning yourself; it's more challenging and rewarding than that."*

Barriers to Mentoring: Why isn't Mentoring Practiced More Often?

- Mentoring is not made a priority in the 'less with more' environment because:
  - There are intense demands on people's time and budgets; the sense of urgency around day-to-day issues means it takes an extraordinary effort to pay attention to mentoring.
  - Our current focus on measurables, deliverables, products, outcomes, results, key performance indicators, etc. makes it very difficult to get credit for less tangible contributions such as mentoring. This hindrance is perhaps most apparent in the academic world where reward is still predominantly earned on the basis of publications and acquisition of research funds.
- Prospective mentors and 'mentees' are sometimes daunted by the belief that things such as personal chemistry and compatible learning styles are key to the success of mentoring relationships, and that these are things that can't be forced – rather, the relationship should arise organically.
- Lack of money can be a problem because it is difficult to attract and keep the 'best and brightest' when organizations or institutions are unable to pay a competitive wage; careers in both academic and non-profit worlds tend to offer low pay and high work loads relative to the skill level and commitment that is demanded.
- The culture of an organization can inhibit mentoring. For instance:
  - The trend toward hiring M.B.A.s into Executive Directors positions in the non-profit world is not necessarily positive; there are many people who would make excellent E.D.s if given leadership training and the opportunity.
  - A competitive internal work environment may deter prospective mentors by breeding the notion that providing opportunities and leadership training to a junior colleague could backfire.

In light of these challenges, what steps can be taken?

10 things YOU can do to make mentoring happen in your own organization:

1. **Commit to making mentoring a priority**. Organizations and individuals need to recognize that short-term crises and long-term investments or programs such as mentoring are inherently different yet equally important to address.

2. **Incorporate mentoring** into organizational strategic plans and follow through by building it into job descriptions, work plans, budgets, performance reviews and approaches to hiring.

- When recruiting new staff, leaders within the organization should be thinking about the organization's evolution and legacy – i.e., 'hiring with the future in mind' rather than just filling current needs. *"When we were hiring a program director a couple of years ago, we should have been thinking we were hiring a future Executive Director."*
- Discuss career trajectories and provide individuals with a clear sense of the opportunities for advancement within the organization's system.
- Offer benefits for recruitment and retention.

3. Help to build a **collegial organizational culture** so that mentors are willing to assume the role and 'mentees' are willing to show initiative by seeking guidance. A mentoring-friendly organization:

- Recognizes and promotes mentoring
- Recognizes that individuals are attracted to organizations/institutions in large part by the people who constitute them
- Works hard to foster an environment characterized by trust, sincerity and encouragement in which people can thrive

4. **Consider the role that funders play, and can play, in developing environmental leadership.** Invest time, in particular, in convincing the Foundation world that funding mentoring or internships is important.

5. **Make effective use of internships** to provide opportunities for the 'best and brightest' students.

6. **Examine learning models from a variety of disciplines and cultures** to learn what they can offer to our practice of mentoring (e.g., through apprenticeships, within indigenous societies, etc.).

7. **Seek out people in the community at large** to mentor people in your organization.

8. Evaluate a range of programs that explicitly address mentoring and **participate** in one that will work for you. **Initiate** a program where you see a need and an opportunity (e.g., capacity-building programs, conservation leadership training programs, conferences and workshops, and sabbaticals specifically intended for mentoring leadership training.)

9. **Bring people together on a regular basis for informal discussion and learning** through peer mentoring or staff student mentoring groups.

10. **Take advantage of existing networks** to establish mentoring relationships (such as the Y2Y Network). Demonstrate leadership by **actively promoting mentoring and mentoring opportunities** in the networks to which you belong.

APPENDIX A – Y2Y CONSERVATION SCIENCE GRANTS PROJECTS 1999-2003

Projects are grouped according to species, taxa or other focal theme(s), and organized alphabetically by title within each of these groups.

Aquatics

Assessing River System Integrity in Western Montana (2001)
Nathaniel Hitt and Len Broberg - American Wildlands

Assessing River System Integrity in the Upper Missouri Basin of Montana: Combining Mainstem River and Watershed Assessments to Drive Conservation Action (2003)
Chris Frissell - American Wildlands

Coarse Filter Analysis of Bull Trout (Salvelinus confluentus) Population Strongholds in the Columbia River Basin of British Columbia (2000)
James Bergdahl - The Lands Council

Fragmentation & Loss of Riverine Wetlands Due to Human Infrastructure (2000)
Suzanne Bayley, Agnes Wong and Ryan Galbraith - Federation of Alberta Naturalists

Avian

Mapping Avian Diversity across the Yellowstone to Yukon Region (2003)
Kingsford Jones and Andy Hansen - Greater Yellowstone Coalition

Mapping Bird Abundance and Community Diversity from Satellite Imagery: Validation of AVHRR and MODIS Models (2001-2002)
Kingsford Jones and Andy Hansen - Greater Yellowstone Coalition

Restoring Severed Migratory Patterns of Rocky Mountain Trumpeter Swans and Reconnection with Essential Wintering Areas (2002-2003)
Rod Drewien and Ruth Shea - Trumpeter Swan Society

The Potential Impacts of Natural Gas Field Development on Sage-Grouse Behavior (2003)
Stanley Anderson - Audubon Wyoming

Carnivores

Banff Wildlife Corridors Project (1999-2000)
Danah Duke - Bow Valley Naturalists

Habitat Selection by Recolonizing Wolves in the Northwestern United States (2001)
John Oakleaf, Dennis L. Murray, Edward E. Bangs, Curt M. Mack, Douglas W. Smith, Joseph A. Fontaine, James R. Oakleaf, Michael D. Jimenez, Thomas J. Meier, Carter C. Niemeyer - Defenders of Wildlife

Inferring Connectivity Among Cougar Populations Along the Central Rocky Mountains Based on Genetic Relationships in a Common Pathogen (2000-2003)
Roman Biek and Mary Poss - Predator Conservation Alliance

Modeling Carnivore Habitat-Use, Travel Patterns and Human Activity around the Town of Canmore, Alberta (2001)
Shelley Alexander, Paul Paquet and Danah Duke - Wolf Awareness, Inc.

Multi-Species Carnivore Habitat Analysis for the Rocky Mountains (1999-2000)
Reed Noss, Carlos Carroll and Paul Paquet - WWF Canada

Noninvasive Monitoring of Grizzly and Black Bear Abundance and Disturbance Levels (1999-2000)
Sam Wasser - Center for Wildlife Conservation

Resilience Profiles for Gray Wolves and Grizzly Bears (2000)
Paul Paquet - Wolf Awareness, Inc.

Southern Alberta Wolf Project (1999)
Carolyn Callaghan, Paul Paquet, Timm Kaminski and Charles Mamo - Wolf Awareness, Inc.

Wolverine Ecology in the Greater Yellowstone Area (2001-2003)
Kristine Inman with Robert Inman, Rachel Wigglesworth and John Beecham - Wildlife Conservation Society

Grizzly Bears

Assessing Connectivity for Grizzly Bear Populations in Northern Idaho and Southern BC (2000)
Troy Merrill and Lance Craighead - Craighead Environmental Research Institute

Eastern Slopes Grizzly Bear Project (1999)
Steve Herrero with Bryon Benn, Mike Gibeau, Cedar Mueller and Jen Theberge - World Wildlife Fund Canada

Grizzly Bear Conservation on Private Lands: Implications for Connectivity (1999 & 2001)

Seth Wilson - American Wildlands and Predator Conservation Alliance

Grizzly Bear Distribution and Movements in the Tobacco Root Mountains (1999)
Scott Creel - Montana Wilderness Association

Grizzly Bear Survey in the Headwaters of the Fraser River (1999)
John Weaver - Wildlife Conservation Society

Grizzly Bear Survey in the Purcell Wilderness Conservancy to Explore Movement and Connectivity Dynamics in the Purcell Mountains of Southern British Columbia (2003)
Michael Proctor - East Kootenay Environmental Society

Integrating Conservation Science and Management with Rural Communities to Enhance Ecological Connectivity for Grizzly Bears on Private Lands in Montana (2003)
Seth Wilson - Northern Rockies Conservation Cooperative

Landsat TM-based Greenness as a Surrogate for Grizzly Bear Habitat Quality in the Central Rockies Ecosystem (2000)
Saundi Stevens and Mike Gibeau - CPAWS Calgary

Population Fragmentation and Connectivity of Grizzly bears across BC Highway 3 in the Purcell Mountains of Southeastern British Columbia, Canada (2001-2002)
Michael Proctor - East Kootenay Environmental Society

Recovering Grizzly Bears in the Cabinet Mountains (2002)
Troy Merrill - Predator Conservation Alliance

Security Area Analysis for Grizzly Bears in the Central Rockies Ecosystem (2001)
Saundi Stevens and Mike Gibeau - CPAWS Calgary/Banff

A Study of Grizzly Bear Movements, Corridor Design Attributes and Management to Minimize Grizzly-Human Encounters in a Protected Wildlife Corridor Across the Central Rockies, Kakwa Provincial Park, BC (1999-2001)
Wayne McCrory - Valhalla Wilderness Society and the Great Bear Foundation

Y2Y Connectivity Analysis and Implementation Project (2003)
Lance Craighead - Craighead Environmental Research Institute

Ungulates

Conservation Assessment and Strategy for Caribou of the Y2Y Region (2002)
James Bergdahl - Selkirk Conservation Alliance

Documentation of Pronghorn Migration Dynamics Relative to a Conservation Easement in the Upper Gros Ventre Drainage, WY (2002)
Tom Segerstrom - Jackson Hole Land Trust

Effect of Snowmobile Activity on Behaviour and Range Use of the Ibex Woodland Caribou Herd in Southwestern Yukon (2003)
Todd Powell - Yukon Conservation Society

Mountain Caribou Habitat Selection along Migration Routes (2003)
Fiona Schmiegelow and Joanne Saher - Federation of Alberta Naturalists

Roads / Road Ecology

Bozeman Pass Wildlife Linkage & Highway Safety Study (2001)
Lance Craighead - Craighead Environmental Research Institute

Multi-scale GIS approach to Modeling Animal Movements across Transportation Corridors in Mountainous Terrain (2001-2002)
Tony Clevenger and Jack Wierzchowski - Bow Valley Naturalists, Friends of Banff National Park and CPAWS-Calgary/Banff

Roads and the Industrialization of Northern British Columbia (2002)
Roger Wheate with Pat Moss - CPAWS - BC and NW Institute for Ecoregional Research

Road Removal Research in the Y2Y Region (2001)
Mark Vander Meer - Wildlands Center for Preventing Roads

Wildlife Use in Relation to Structure Variables for a Sample of Bridges and Culverts Under I-90 between Alberton and St. Regis, MT (2002)
Chris Servheen with Rebecca Shoemaker and Lisa Lawrence - American Wildlands

Other

Assessing Trends in Whitebark Pine Population Decline - Maintaining Connectivity for a Rocky Mountain Keystone Species (2003)
Cyndi Smith - Whitebark Pine Ecosystem Foundation

Biodiversity Survey in the Wolf Lake Ecosystem (1999)
Dave Mossop with (1999, Nisutlin Lake, Wolf River and Morris Lake): Alejandro Frid, Rhonda Rosie, Brian Slough, Bruce Bennet, Dave Jones, Marty Strachan, Dennis Kuch, Larry Gray and (2000 Red River Lake and Crescent Lake): Rhonda Rosie, Brian Slough, Rem and Randi Mulder - CPAWS-Yukon

Conservation of Long-toed Salamanders in the Alberta Foothills (2002)
Lisa Wilkinson - Alberta Conservation Association

Delineation of the InlandRainforest Phenomenon of North America: a Lichenological Perspective (2001)
Toby Spribille and Trevor Goward - Global Forest Science

Dispersal and Population Persistence in the Alpine Dwelling Hoary Marmot (2002)
David Hik with Tim Karels, Gerda Ludwig and Christine Cleghorn - Yukon Conservation Society

Transboundary Cumulative Effects Analysis - Castle/Flathead Ecosystem (2000)
Craig Stewart / Miistakis Institute - CPAWS-BC

Wildlife, Fisheries and Recreational Resource Values in Wood River Area of the Columbia (Golden) Forest District (1999)
Dennis Hamilton - East Kootenay Environmental Society