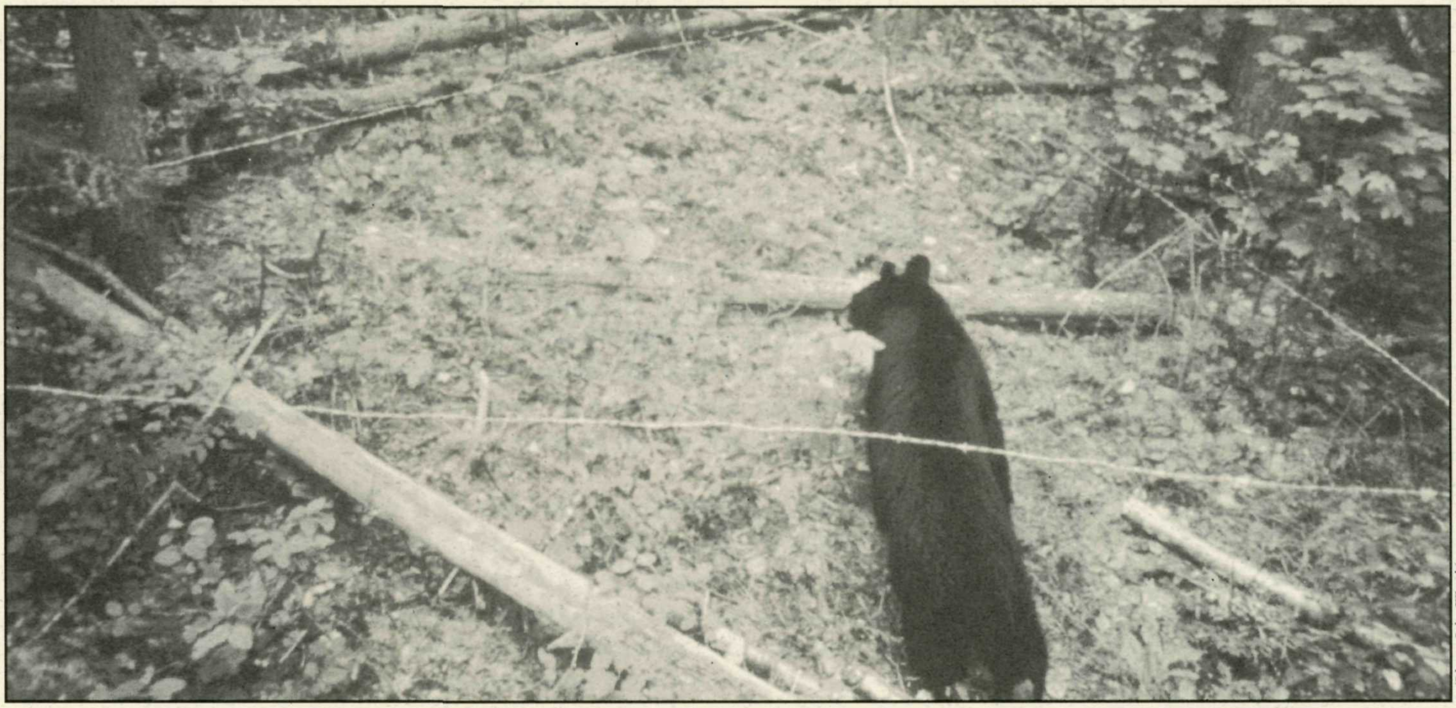
Research Links
A Forum for Natural, Cultural and Social Studies

Ecological Research on Bears Using

DNA Fingerprinting



(Photo: John Woods)

A black bear going under a strand of barbed wire and leaving behind a hair sample used to produce a DNA fingerprint

David Paetkau and Curtis Strobeck

Molecular genetic studies of wild animals have the potential to enhance our understanding of relationships within and between natural populations. In the past, however, most genetic work on large mammals has focused on the evolutionary relationships between distinct groups, and not on ecological-scale questions. The goal of this project was to develop modern genetic markers (in particular, "microsatelites" or "short tandem repeats"), like those used in human genetics for DNA fingerprinting and locating disease genes, to address questions of relatedness in bears (Paetkau and Strobeck 1994, Paetkau *et al.* 1995). This work is best done in conjunction with field studies because samples can be collected by field workers and because field observations are often critical to data interpretation.

The Eastern Slopes (ES) Grizzly Bear Project and the West Slopes (WS) Bear Project are ongoing research projects in parts of Banff, Yoho, and Glacier National Parks as well as adjacent provincial lands. Both are large interagency projects involving Parks Canada, provincial land use agencies, and several private sector groups. We now receive samples from all black bears *(Ursus americanus)* and brown bears (*Ursus arctos*; the common name for this species in parts of its North American distribution is "grizzly bear," but "brown bear" is the universal common name) handled in these projects. Each of these animals is now typed at eight or more highly variable genetic markers. These eight-locus genotypes are a permanent genetic identifier, or "DNA fingerprint," that, once described, can positively identify an individual from any DNA sample. These DNA fingerprints can be used to address a variety of questions.

The most obvious application of a DNA fingerprint, the identification of multiple samples from the same individual, has clear utility in forensics (for example, our lab has worked on numerous forensic cases involving bears, and other animals, shot illegally within and outside of national parks), but may also be extremely useful in the context of a capture-recapture population census. Two trials of this approach were carried out in the WS study area in 1995. In these trials, the source of DNA was hair collected in scent-baited barbed wire enclosures. Three hundred and fifty hair samples were collected in this manner, and DNA finger-

– *continued on page 6* –

Research Links

Volume 4 • Number 1 • Spring 1996

FEATURE ARTICLES

DEPARTMENTS

FRANCOPHONES

Le texte de cette publication est offert en français. Vous pouvez l'obtenir en écrivant a l'adresse dans la p. 16.

SUBMISSIONS WELCOME FOR FALL ISSUE. DEADLINE IS JULY 5, 1996.

EDITORIAL

I have always been impressed by the wide variety of research projects going on in our national parks. I have been *impressed*, but not surprised. The breadth of research ideas are limited only by the creative minds of the individual researchers. Previous issues of *Research Links* have tried to bring out a variety of research in the natural, cultural, and social sciences and this issue is no different in that respect. What *is* unique about this issue is that the articles are subtly united by a common thread: the authors are affiliated with the University of Alberta, in Edmonton. We hope you enjoy this, our tenth issue, from that perspective.

I would also like to introduce you to a new member of our production team, Dianne Willott. Dianne holds degrees in ecology and English literature, and with her diverse background, she will bring fresh ideas to *Research Links.* Welcome, Dianne.

It is time to mark a date on next year's calendar. The third International Conference on Science and the Management of Protected Areas (SAMPA) will be held in Calgary from May 12 to 16, 1997. Twice, SAMPA has served as a forum for presenting and discussing current perspectives on the role of science in managing protected areas and the role of protected areas in the conduct, support and promotion of scientific research. A special marine symposium will again be part of the conference, and pre and post conference tours will highlight marine and terrestrial protected areas. We are excited about hosting the conference for its Western Canada debut, and *Research Links* will bring you more details in coming issues.

Like many other publications, we started encouraging you to look us up on the Internet. Some of you have, and have experienced frustration in finding us one day and not the next. Let me explain. Parks Canada, as part of the Government of Canada, has an obligation to make its public information available in both official languages. The policy is clear for printed material that is available to the public, but it is still evolving with respect to documents on Internet. *Research Links* is considered an "in house" rather than a "public" document, and as such can be produced in English only. (However, you may have noticed that French translations of the text are available by request.) When we have completed our move to the Internet, a public medium, you will be able to access *Research Links* in the official language of your choice.

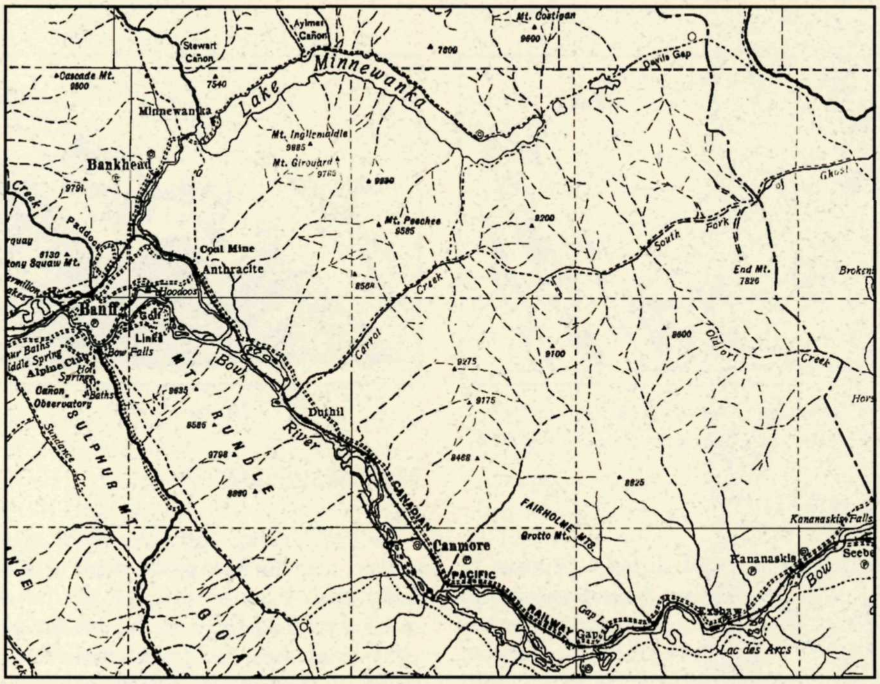
We will continue to make *Research Links* available on paper as well as electronically. Readers who prefer an electronic copy may contact us for information about specific formats. We will keep you up-to-date as details become available.

The highlight of each Editorial Board meeting occurs when we hear what you, our readers, have to say. Whether it's a pat on the back, a rap on the knuckles, or simply your best ideas, we enjoy hearing your thoughts.

Patricia Benson
Editor

On the map

National Parks Maps in the William C. Wonders Map Collection



Sandy Campbell

The William C. Wonders Map Collection is part of The Science and Technology Library at the University of Alberta, and is housed in Cameron Library. It is the largest university map collection in Canada, and contains a substantial collection of maps related to national parks.

The core of the collection is made up of several hundred miscellaneous topographic and thematic maps covering most of the national parks. They range greatly in date and scale. The strength of this part of the collection is in materials related to parks located in Alberta and Northern Canada, particularly Banff, Jasper, Wood Buffalo and Elk Island National Parks. Among the unusual maps in the collection are a set of 1950s topographic maps of Wood Buffalo National Park complete with manuscript annotations by William C. Wonders. These topographic maps show relief as well as man-made features, timber berths, communications services and whooping crane nesting areas, among other things. Other maps of interest include a 1926 "Trail Rider's Map of Rocky Mountains, Yoho and Kootenay National Parks," the 1888-1892 Topographical Survey of the Rocky Mountains which shows Lake Louise as Laggan, and satellite photomaps (aerial photographs to which cartographic information had been added) of Jasper and Banff, produced by the Northern Forest Research Centre in the 1970s. The collection also includes a set of photomaps showing the soils of Waterton Lakes National Park, and forest cover and biophysical maps for some of the parks. There are also many tourist maps.

Many other maps related to national parks are found in large series. For example, twenty-three sheets of the National Topographic Society (NTS) series, at the 1:50 000 scale, cover parts of Jasper National Park. The Map Collection is a Federal Depository Collection, and holds all sheets of the NTS series at both 1:50 000 and 1:250 000 scales. The Geological Survey of Canada series also contain many maps relating to national parks.

Maps in the circulating collection can be viewed on the main floor of Cameron Library and most may be borrowed through inter-library loan. For an appointment to view rare and old maps, call (403) 492-7912.

Sandy Campbell *is a Reference Librarian at the Science and Technology Library of the University of Alberta. For further information please call (403) 492-7915, or e-mail: sandy.campbell@ualberta.ca.*

FEEDBACK...

"I read with great interest the article on "Cultural Depressions" in the Winter 1995 issue of *Research Links*, being one of the glaciologists who occupied the Drummond Glacier housepit in 1962, 1963 and 1964. We always wondered about those depressions! Being geoscientists, we interpreted the features variously as ice melt-out pits and fluvial scour features. The truth is much more interesting and significant. Thank you to E. Gwyn Langemann and associates."

As I recall, one of those associates, Don Mickle, was working as a wrangler for his father Bert in 1963 and packed us to the site... Good luck with your future work on the pithouses. I hope our presence at the site did not unduly disturb the remains of the pithouses.

– *James S. Gardner,*
Vice-President Academic and Provost,
University of Manitoba

We Goofed!

As we are now aware, the photograph of a "wolf" printed in the Natural Region Highlights section (page 9) of the Winter 1996 issue of *Research Links* is not a wolf *(Canis lupus)* at all. It is in fact a coyote *(Canis latrans)*.

Coyote *(Canis latrans)*

Wolf *(Canis lupus)*

Thank you to our readers for setting us straight!

UNSTABLE GROUND

Assessing the Risks of Rock Slides

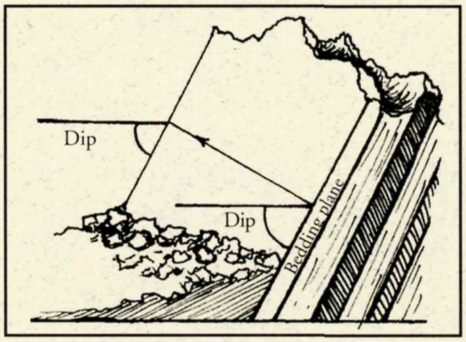
David M. Cruden

On July 2, 1992, approximately one million cubic metres of dolomite fell from the northeast face of Chief Mountain, a 2 768 m high landmark on the northern boundary of Glacier National Park, adjacent to the Blackfoot Indian Reservation, 7 km south of the Canadian border in Montana. The rock fall was probably the result of the preceding weeks' heavy rain, combined with freezing overnight temperatures, and may have been triggered by an earthquake with an epicentre about 50 km southwest of Chief Mountain (Schuster *et al.* 1995).

Debris from previous Chief Mountain landslides, saturated by the heavy rains, was struck by the newly displaced rock. This impact reactivated dormant landslides. Landslide debris flowed as much as 4 km from the base of the peak, overturning and burying coniferous forest. After a week, the rate of debris flow slowed to 100 m per day, but movement continued for up to a month after the event on slopes with inclines as slight as 9 degrees. The volume of material displaced was about 10 million cubic metres. Neither people nor structures were in the path of the landslide, and no casualties were reported. Following the landslide, the area covered by deposits was logged to salvage commercial timber and to reduce fire risk.

The possibility of a major landslide, like the one from Chief Mountain, poses problems for facility planners and program developers in Canada's Mountain Parks, since constructing a facility in the path of a future landslide should be avoided if possible. Risk analyses could be conducted (Canadian Standards Association 1991) to estimate the likelihood of such an occurrence.

Mt. Rundle has a scarp slope (east face, left) and a dip slope (west face, right)

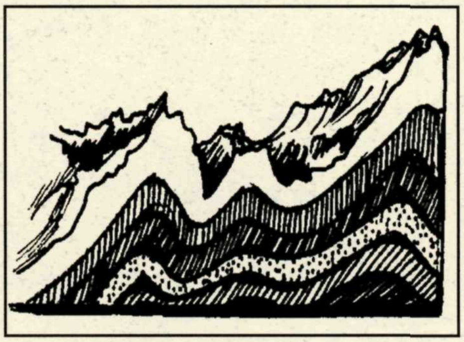


Dip is the angle formed between an imaginary horizontal plane and the bedding plane

THE HISTORY

Reconnaissances of surficial deposits in the Rockies of Alberta have located 935 large rock slides in an area of approximately 60 000 km^2, a density of 1.57 rock slides per 100 km^2 (Cruden 1985). It takes thousands of years for a major rock slide to become sufficiently overgrown by natural vegetation to be obscured in a reconnaissance survey. Above the tree line, only erosion or deposition by colluvial, alluvial or glacial processes obscures the evidence of old landslides. Thus, close to and above the tree line, the number of visible landslides represents a reasonable estimate of the accumulation of events since the Wisconsonian retreat of the glaciers 10 000 years ago. In more moderate climates the record may be only half as long. As a result, visible landslides represent the accumulation of 5 000 years' activity, and on average we can expect a major landslide in the Canadian Rockies every 5 years or so.

Records suggest that present day frequencies of landslides are less than prehistoric frequencies (Cruden 1996). Current landslide frequency estimates range between occasional (once every 10 years), and remote (once every 100 years), on the CAN/CSA matrix (1991, p. 22). Damage from recent landslides has been minor , but the possibility remains for catastrophic collisions between traffic and landslide debris on parks' highways. Given these frequency and damage statistics, qualitative risk assessment is warranted.



Fabric relief

THE ASSESSMENT

In 1987, along with Dr. Eaton, I conducted a qualitative assessment of risk in Kananaskis Country to guide the development of facilities there. In this assessment we considered the relationships between rock structure, the dip of the bedding planes within the rock mass, and rock slope orientation.

The Canadian Rockies show "fabric relief" (Cruden 1988), meaning that their topographic relief is correlated with the structure of the rock underlying the topographic surface. In particular, the long, northwest trending mountain chains that form the Front and Main Ranges of the Rockies parallel the axes of the folds into which their layers of sedimentary rock have been pushed. The chains are formed from dip (or cataclinal) slopes and scarp (or anaclinal) slopes. Dip slopes in the parks tend to be the steepest in the same direction as the dip, or the slope of the sedimentary rock beds from which the slope is cut. Scarp slopes are steepest at an angle of 180 degrees to the dip of bedding in the rock.

Our studies in Kananaskis Country showed that rock slides tend to be most frequent on cataclinal slopes. They were particularly frequent on slopes which are steeper than both the dip of the bedding (overdip slopes) and the angle of friction of the rock mass. The slides which took place at Mount Sparrowhawk and Palliser are examples. Therefore, construction and activities near the base of such slopes should be avoided.

Anaclinal slopes are subject to small falls and slides which rarely extend beyond the "toes" of the slopes. Debris from this type of slide might easily be caught by ditches or berms. However, one oversteepened scarp slope in Kananaskis, Elk Ridge, has experi-

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Dynamics of Alpine Larch at the Timberline

Brendan Wilson

WHAT ARE ALPINE LARCH?

Alpine larch *(Larix lyallii)* are deciduous conifers which exist in limited areas of the upper subalpine forest, timberline, and alpine meadows. This species, renowned for its brilliant yellow autumn display, is found most commonly on the cooler, northern slopes. But in the Rocky Mountain national parks, there are also smaller stands inhabiting some of the gentler, southern slopes. Banff, Kootenay and Yoho National Parks are home to the most northern populations of this species, the distribution of which extends south down the Rockies into Montana and Idaho. Alpine larch are also found on the eastern slopes of the Cascade Mountains in Washington and British Columbia.

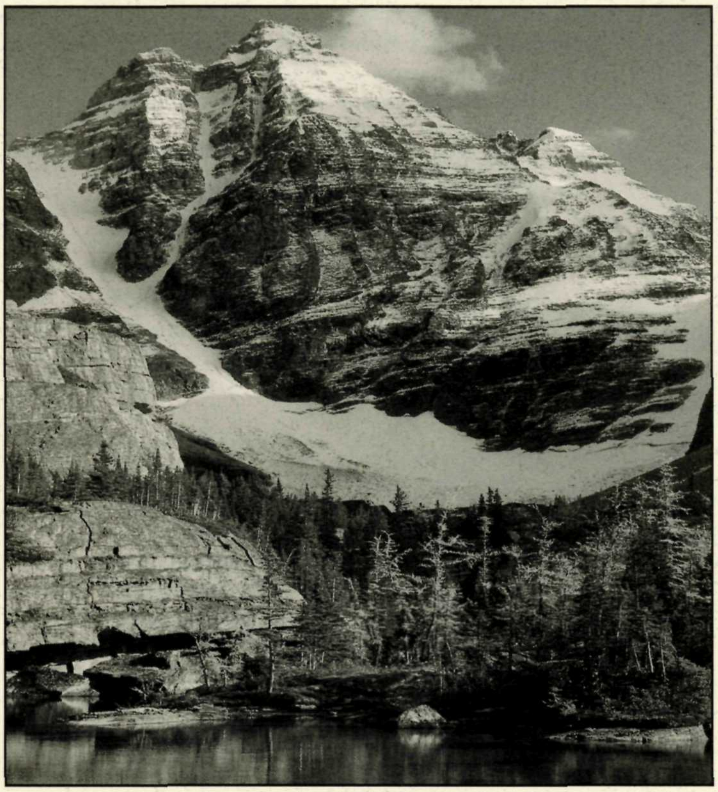
Alpine larch is one of the ten species found in the *Larix* genus world wide. Five of the other species occupy niches similar to those of alpine larch on other continents. Travelers in timberline areas of western Europe, Asia and Japan could expect to see these similar species.

TIMBERLINE ENVIRONMENTS

Timberline can be defined as the ecotone or transition zone between subalpine forest and treeless, alpine tundra. Timberline environments are characterized by high wind speeds, cool annual temperatures and often rapid temperature fluctuations. This can be contrasted with the more stable environmental conditions likely to be found at the base of forested, montane valleys.

While the existence of a timberline is most likely a combination of several environmental and biological factors acting together, temperature is the only general environmental indicator which correlates with this transition zone. On a world wide basis, an average temperature of 10° C or less during the warmest summer month usually means that a given location is unlikely to support typical forest vegetation. This relationship appears to be true regardless of whether the transition from continuous tree canopy cover to tundra is in the alpine or in the arctic.

The timberline is dynamic. It moves in elevation with changes in the world climate. For example, paleobotanical studies have revealed that, about 3000 years ago, the local timberline in the Lake O'Hara area of Yoho National Park was approximately 90 m higher in elevation than it is at present. Apparently, cooler temperatures since that time have left us with the present patterns of vegetation.



Alpine larch in Yoho National Park

Today, scientists are concerned about how human activities affect the world's climate, and they wish to learn the consequences of apparently rapid global warming for alpine species, which depend on the narrow range of conditions which exist in the high mountains. Numerous species extinctions may potentially occur in mountainous regions where suitable soil and temperature conditions no longer exist above the species' present habitats. While climactic changes of this magnitude have occurred before, rapid increases in atmospheric carbon dioxide and associated global warming could happen at rates substantially faster than "natural" climate change and therefore could outstrip the ability of species to either "migrate" or compete effectively for resources in their present, high altitude habitats.

PHYSIOLOGICAL ADAPTATION

To make informed predictions about the effects of changing environmental conditions on vulnerable species like alpine larch, we need to have an understanding of both basic species ecophysiology and population ecology. Trees living within the timberline environment have to cope with a number of general problems including cold temperatures, short growing seasons and potentially damaging wind speeds. Winter conditions in these high altitude habitats present tree species with two additional problems which severely affect the overall fitness of individuals: (1) abrasion caused by wind blown snow and ice to exposed needles, and (2) desiccation caused by warm air events (such as inversions and Chinooks).

Desiccation, or severe water loss from needles and adjacent branches, can occur when the soil is still frozen and the tree is unable to replace the lost water immediately. One damaging effect of water loss is often apparent by the presence of necrotic or dead needles on high elevation subalpine fir *(Abies lasiocarpa)* and Englemann spruce *(Picea englemannii)* trees. Krummholtz, or shrub-like patches of fir, and to lesser extent spruce, in exposed timberline areas are vegetative responses to the "pruning" action of wind blown snow and ice particles on soft tissues exposed above the winter snow pack.

Alpine larch deal with these two problems quite effectively by discarding needles at the end of each growing season. This adaptation eliminates water loss through needle-leaf surfaces caused by warmer air temperatures, and limits tissue damage due to wind borne particle abrasion. The energetic trade-off is that alpine larch need an adequate, constant supply of water in the summer and high levels of light, to make a new set of needles in addition to generating overall growth at the start of each growing season.

The alpine larch's high moisture requirement helps explain its distribution on a local scale. Alpine larch are limited to the wet, high, northern slopes or other areas where they can obtain an adequate supply

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Ecological Research on Bears

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printing identified 17 bears that had been physically captured at other times and 40 animals that had not been captured before (Woods et al. 1996). The species and sex of these individuals were also identified with genetic markers. These results are now being used to design a large scale DNA-based population census starting in the summer of 1996.

The markers used to obtain DNA fingerprints are Mendelian genetic markers - meaning that two identifiable copies of each marker are present, one maternally inherited and the other paternally inherited. This simple pattern of inheritance makes it possible to search for parent-offspring relationships among all the individuals whose genotypes are known. This approach is particularly powerful when mother-offspring relationships are known, and information about fathers is sought. Several fathers have been identified for offspring captured with their mothers in the ES and WS projects, and this type of pedigree information should increase dramatically with sample size.

Craighead *et al.* (1995) demonstrated the utility of pedigree analysis for studying male productivity and multiple paternity within litters of brown bears. Another possibility is to combine pedigree information with telemetry data to study the relative positions of the home ranges of parents and their offspring. Radio telemetry has already shown how individual bears captured in national parks often move into other jurisdictions (Raine and Riddell 1991), and learning about the area occupied by males and females and their adult offspring is another important step towards understanding the geographical requirements of bear populations, and the degree to which the maintenance of these populations in national parks depends on areas outside the parks.

In addition to identifying individuals and their relatives, genetic data for a number of individuals from each of several populations can be summarized, and the amount of genetic diversity within and between populations can be measured. While connectedness between populations can be important for demographic reasons, there is also concern that populations maintain genetic diversity through connections to large metapopulations. One issue of concern is the avoidance of inbreeding depression, which occurs when populations become too small and lose most of their genetic diversity. A second problem is that, without genetic diversity, populations lack the potential to evolve in response to changes in their environments.

POPULATION	PROBABILITY OF IDENTITY* (one bear in...)
Black Bears	
Eastern Slopes	5,000,000,000
West Slopes	5,100,000,000
La Mauricie NP	8,300,000,000
Terra Nova NP	1,300
Brown Bears	
Eastern Slopes	8,800,000
West Slopes	6,300,000
Kluane NP	230,000,000
Richardson Mts†	290,000,000
Kodiak Island	93
Yellowstone NP	160,000

* The probability that two unrelated individuals drawn from a population at random will have identical eight-locus genotypes

† East of Ivaavik NP, Yukon

Table 1. Genetic diversity in several representative populations of bears

Using DNA fingerprint data, the amount of genetic diversity was measured within the black and brown bear populations in the ES and WS study areas. The same analysis was also carried out on over 1000 black and brown bears from across their North American distributions *(Table 1).* Black bears from the two study areas have very high levels of genetic diversity, and there is no evidence to suggest that factors such as habitat fragmentation, which isolate groups of animals from the metapopulation gene pool, have had much impact. By contrast, ES and WS brown bears show lower levels of diversity than relatively undisturbed northern populations. This observation may be a natural feature of ES and WS bears, but it is likely that anthropogenic factors have also played a role.

Insight as to the consequences of long-term isolation were gained by studying insular populations including black bears from Terra Nova National Park, on the island of Newfoundland, and brown bears from Kodiak Island. Individuals on these islands, which have over 6000 and 2000 animals respectively, have dramatically reduced levels of genetic variation. Similarly, several peninsular brown bear populations in northern Canada and Alaska show moderate reductions in diversity. Bears in the isolated Yellowstone ecosystem appear to have suffered very rapid losses in genetic diversity, although absolute levels are still moderate. All these indicators suggest that the maintenance of genetic diversity, in populations of bears in the national parks of southern Alberta and British Columbia is highly dependent upon continued gene flow with the larger North American metapopulation. It is hoped that future research will include continued monitoring of genetic diversity within this area as well as more detailed studies of natural and anthropogenic barriers to the dispersal of bears.

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Pine and Spruce Species and their Hybrids Provide Gene-Pool Information

Om P. Rajora, Phambu D. Khasa and Bruce P. Dancik

BACKGROUND

Genetic biodiversity (biodiversity at gene level) enables organisms to adapt and evolve because it results in a variety of physical and chemical characteristics within a single species. For example, some members of a tree species may be genetically susceptible to fungal infection while other members, which carry a different form (allele) of the gene, are not. In this way genetic diversity helps to protect against disease, parasites and other factors which could potentially lead to species extinction. National parks, with their large forests, represent a precious repository of gene pools and thereby function as gene conservation areas.

Determining the extent, pattern, spatial distribution and underlying causes of genetic diversity, in addition to the effects of natural and human disturbances on gene pools, can lead to more effective conservation strategies and better management of forest resources. Knowing this information can also enable us to identify and develop genotypes with traits desired for artificial regeneration. For future ecosystem stability and successful, sustainable, forest management, it is important that we find ways to maintain genetic diversity in natural and artificial forests. We hope that genetic information such as we obtained in our studies will soon have valuable applications in the forestry industry.

INTRODUCTION

White spruce *(Picea glauca)*, Engelmann spruce *(Picea engelmannii)* and their hybrids, as well as lodgepole pine *(Pinus contorta* var. *latifolia)* and its hybrids with jack pine *(Pinus banksiana)*, are biologically and economically important species, and they are the principal forest tree species in Banff and Jasper National Parks. In the national parks of southwestern Alberta, the natural range of white spruce overlaps with that of Englemann spruce, and the natural range of lodgepole pine overlaps with that of jack pine. In these parks, natural interspecific hybridization among closely related pine or spruce species has been reported. It has been theorized that pre- and post-glacial migrations separated and then reunited these species pairs.

In order to determine the extent of genetic diversity within and between species, and preserve rare and useful genetic traits for use in the future, we must understand a multitude of factors. These include: the extent, spatial distribution and underlying mechanisms of genetic diversity, the degree of interspecific hybridization, and interspecific genetic and evolutionary relationships. We must also be able to clearly differentiate between the species and their hybrids. We have been conducting research on these genetic aspects of lodgepole pine, jack pine, white spruce, and Engelmann spruce in Banff and Jasper using biochemical (allozymes) and molecular (DNA) markers.

LODGEPOLE PINE AND JACK PINE

Studies on genetic diversity and evolution of lodgepole pine and jack pine were initiated by Bruce P. Dancik in the 1980s and they were subsequently conducted by associates in collaboration with David B. Wagner of the University of Kentucky. Allozyme genetic variability data supports the theory that lodgepole pine and jack pine are closely related species, and a rough estimate indicates that these species diverged about 500,000 years before present (Dancik and Yeh 1983). Analysis of chloroplast DNA (cpDNA) polymorphisms from samples taken throughout the ranges of lodgepole pine and jack pine identified diagnostic species-specific cpDNA restriction fragment length polymorphisms (RFLPs) and revealed that cpDNA is paternally inherited in these pine species (Wagner *et al.* 1987).

In a subsequent survey of about 900 lodgepole pine and jack pine individuals from two overlapping populations, a large number of cpDNA variants, which were not observed in the non-overlapping ranges of these parental species, were identified (Govindaraju *et al.* 1989). These results show that genetic complexity and rare hybrid variants can occur in chloroplast genomes. The study also identified cpDNA variation within individual trees of jack pine-lodgepole pine overlapping regions (Govindaraju *et al.* 1988), providing evidence that variation within individuals may be an important source of genetic variability in overlapping regions of forest trees.

A more recent study examined the spatial distribution patterns of cpDNA and cone morphology within two lodgepole pine-jack pine overlapping regions (Wagner *et al.* 1991). Polymorphism variants were found to be non-randomly distributed, with several variants arranged in conspicuous clusters. These spatial patterns are consistent with the theories of differential selection among microenvironments, recent introduction of new variants, and limited gene flow between the two species. The results of Wagner's (1991) study suggests that hybrids can be confined in space, forming overlapping populations within which one of the parental genotypes is infrequent.

WHITE SPRUCE AND ENGELMANN SPRUCE

Om P. Rajora initiated a study on population genetic diversity, structure and evolution in Engelmann spruce, white spruce and their hybrid species in 1988. This study has been resumed by Phambu Khasa since 1993. For some time we have known that white spruce is a low-elevation species (<1300 m), Engelmann spruce is a high-elevation species (above 2000 m), and their hybrids occur between low and high elevations (LaRoi and Dugle 1968). However, the task of determining the degree of hybridization requires much more detailed information which must be obtained from biochemical and molecular genetic techniques. Even an allozyme variability survey of 14 white spruce, Engelmann spruce and their hybrids could not identify any species-specific alleles (Rajora and Dancik 1996), although we know now that the species can be differentiated.

Analysis of genetic material showed that Englemann spruce and white spruce differed both in their allele frequencies at several loci and in their allozyme genotypes (as determined by multivariate analysis). We found that trees we suspected were hybrids were genetically more similar to white spruce than to Engelmann spruce

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RESEARCH

U of A Researchers are Experts in Many Disciplines

W. Adamowicz	Rural Economy	Economic aspects of environmental problems
S. Bayley	Biological Sciences	Model forest studies
R. Belland	Biological Sciences	Bryophytes in Jasper National Park
T. L. Burton	Physical Education	Recreational policy and planning
J. R. Butler	Renewable Resources	Economics, planning and management
S. Campbell	Sci. and Tech. Library	Comprehensive mapping of national parks
L. N. Carbyn	Boreal Institute	Parks recreation, management and ecology
G. M. Coen	Soil Science	Mountain ecology
D. M. Cruden	Civil Engineering	Landslides in the Rockies
R. Currah	Biological Sciences	Fungal-plant interactions in alpine glacial areas
M. Dale	Biological Sciences	Kluane ecosystem project
B. P. Dancik	Renewable Resources	Forest ecology
A. A. Einsiedel	Extension	Development and training of Parks managers
J. Gartrell	Sociology	Human attitudes and behavior
S. Hambleton	Biological Sciences	Evolution of fungi
G. Hanna	Physical Education	Active living and environmental citizenship
J. Hart	English	Aboriginal-European encounters
R. Heron	Physical Education	National parks, historic sites and museums
E. Higgs	Anthropology	Model forest studies
C. Hickey	Biological Sciences	Archaeological information from model forests
M Hickmann	Biological Sciences	Paleoecology and aquatic plants
T. Hinch	Physical Education	Sustainable tourism
E. L. Hughs	Law	Environmental protection in national marine parks
S. Hrudey	Medicine	Environmental risk management
E. Jackson	Geography	Interactions between leisure and recreation
L. Laing	Medicine	Native health issues
R. A. Laux	Law	Administrative law
H. T. Lewis	Anthropology	Aboriginal perspectives
S. E. MacDonald	Renewable Resources	Forest ecology in Banff
H. Machel	Geography	Isotopic constraints on fluid flow in the Alberta basin
J. Martin	History	Model forest studies
J. S. Nelson	Biological Sciences	Alberta fish
B. Nesbitt	Geography	Fluid history associated with folds and thrust belts
R. Polziehn	Biological Sciences	Genetic variability in Jasper elk populations
O. P. Rajora	Renewable Resources	Pine and spruce hybrids
D. Schindler	Biological Sciences	Land-water interactions in a model forest
C. Schweger	Anthropology	Paleoecology and human disturbances
J. Spence	Biological Sciences	Entomology
C. Strobeck	Biological Sciences	DNA fingerprinting of bear and elk in Banff and Jasper
G. S. Swinnerton	Physical Education	Conservation policies
D. Vitt	Biological Sciences	Indicators in model forests
R. W. Wein	Renewable Resources	Vegetation in Wood Buffalo National Park
D. Whitson	Physical Education	Culture of sports and leisure
F. Wilhelm	Biological Sciences	Invertebrates in Mildred and Patricia Lakes
B. Wilson	Biological Sciences	Alpine larch regeneration dynamics
P. M. Woodard	Renewable Resources	Forest fires in Banff National Park

HIGHLIGHTS

JOHNATHAN HART
English

"Identification with and alienation from the land are contradictory human impulses. This contradiction begins early in Western poetics, philosophy, religion and historiography and travel narratives. The deadening of the land as something to be exploited conflicted with the simultaneous view of the earth as a garden whose heavenly qualities needed to be regained. If in the "postmodern" period we use different, displaces or refracted versions of this split, we still experience a divided view of nature. It is there to admire and exploit. If anything, industrial and technological developments have intensified this division, perhaps to the point of a cultural schizophrenia. However, the military, industrial and technological powers now in human possession are far beyond the sublunary vantage of John in Revelation. By looking at some of the moments of this natural divide in Western intellect, it is possible that [we can] reform some of the problems and pleasures in our relation to nature. It may be the human lot to love, fear and consume nature at once. But we need not forget the option of regeneration."

FREDERICK A. LAUX
Law

Prior to 1990, the responsibility for administration, management, and control over Banff National Park was placed on the federal Environment Minister as delegated by the *National Parks Act, 1930.* No one was pleased with this arrangement. Banff townsite residents perceived that decisions made by Parks Canada were not made in the best interests of the community. Parks Canada believed that townsite management distracted and deflected resources from their main mission of administering Canada's national parks for the benefit of all Canadians. F. A. Laux served as a consultant for the Department of Justice during negotiations between the federal and provincial governments. His research on the constitutionality of the *Town of Banff Incorporation Agreement* concludes that the agreement, which led to Banff's municipal incorporation in 1990, would survive a constitutional challenge. His analysis of the municipal incorporation of the Town of Banff serves to document a significant innovation in the constitutional delegation powers between the federal and provincial governments, and highlights some of the possible problems with the agreement.

S. ELLEN MACDONALD AND B. P. DANCIK
Renewable Resources

With the possibility of global environmental changes occurring in the next one hundred years, trembling aspen may be severely affected. S.E. MacDonald and B.P Dancik propose to assess how different types of trembling aspen will respond to environmental changes. By collecting samples of aspen with different genetic makeups from areas in Alberta including Banff National Park, they will evaluate the effects of variations in environment on aspen survival, growth, and physiology. It is hoped that this information will allow for accurate predictions of future growth and survival of aspen, and identify aspen with a genetic makeup that encourages productivity in potential future environmental conditions.

DAVID SCHINDLER, CHARLES SCHWEGER AND MICHAEL HICKMAN
Biological Sciences

"In order to develop a management plan which would approximate natural fire regimes for Jasper National Park (JNP) forests while excluding certain vulnerable areas near human developments, it would be desirable to have a longer record of the history of fire and other disturbances, and the changes in forest species with time following disturbance events. An understanding of fire history is also critical [so we can understand] the interplay between fire, forest carbon balance, and global warming.

[We are working to reconstruct] forest disturbance and successional history using analysis of pollen, plant macrofossils and charcoal layers preserved in sediments of known age from JNP lakes. If successful, such techniques could probably be applied to other areas of the mountain parks."

ROSS W. WEIN
Renewable Resources

By conducting prescribed fire burns at four sites between Nordegg and Sundre, Alberta, towards the boundaries of Banff National Park, R. W. Wein and graduate student. W. J. DeGroot expect to delineate how fire can best be used to remove bog birch from traditional elk wintering grounds in order to restore elk habitat. The objectives of the study include determining the impact of fire severity and season of burn on the sprouting ability of bog birch, assessing the impact of fire upon other plants in the ecosystem, and identifying the best sites for prescribed fire burn. The information will be used to develop operational guidelines for the removal of bog birch from elk wintering habitat using prescribed fire.

P. M. WOODARD
Renewable Resources

One aspect of P. M. Woodard's research focuses on assessing the impact of tree harvesting in the Rocky Mountains on wild ungulates such as elk. By identifying changes in movement patterns, determining how harvested habitat areas are used, describing changes in forage plants, and assessing changes in diet, he will evaluate the impact of tree harvesting in Bighorn Creek Valley (in the Banff National Park region) on elk. It is expected that this research may complement related research conducted elsewhere with Alberta-specific results.

POLICIES AND PARTNERSHIPS

National parks in England and Wales are clearly very different from Canada's national parks in terms of park environments, organizational structures and the statutory powers of park authorities. However, there is now increasing worldwide recognition that protected areas are inextricably linked to surrounding land and communities. This recognition, combined with an era of government restructuring and the need for innovative ways to stretch limited tax dollars, has focused attention on the potential benefits of partnerships and cooperative ventures. National Park Authorities in England and Wales have demonstrated a number of partnerships and ventures both at organizational and operational levels.

Parks Canada's current Guiding Principles and Operational Policies recognize the growing importance of collaboration in achieving heritage and land conservation. The partnership experiences of British National Park Authorities provide some useful insight regarding this evolving approach to park management. The considerable number of different partnership types in the UK, and the diverse interests of the many stakeholders, including public agencies, private and commercial sectors, and special interest groups, are immediately apparent. Consequently, National Park Authorities have had to rely on less formal structures and processes to compensate for their limited statutory powers and budgets. As a result of multi-stakeholder relationships, these authorities adopt coordinating and facilitating roles instead of functioning as dictating and controlling bodies.

Protected Landscapes:

Guy S. Swinnerton

INTRODUCTION

From a global perspective, protected areas exhibit a variety of management objectives. However, areas which include cultural landscapes and modified natural systems are becoming increasingly recognized as landscapes worthy of protection. These areas are classified as Category V - Protected Landscape/Seascape by the World Conservation Union (IUCN 1994). Although, Category V areas account for only 15.2 per cent of the protected area worldwide and 11.4 per cent of Canada's protected area, a markedly different situation exists in the UK (England, Wales, Scotland and Northern Ireland). In the UK, 95.9 per cent of the total protected area, including national parks, is classified as Protected Landscape/Seascape. National parks in England and Wales contain a significant amount of semi-natural landscape, meaning that recreation and tourism are permitted within the normal lifestyle and economic activity of the area.

THE RESEARCH PROGRAMME

The purpose of my research programme has been to examine the concept of protected landscape as it is exemplified by national parks in England and Wales. More specifically, I have focussed my attention on the role of partnerships and cooperation in the planning and management of these areas.

National parks in England and Wales are designated on land that has already experienced a long history of human occupation, private land ownership, and existing administrative and planning structures. Consequently, a partnership approach is essential if the two legislated mandates of the national parks, conservation and recreation, are to be achieved. Two areas of partnership have been examined: first, the role of partnerships in landscape conservation, and second, the importance of a partnership approach in the planning and management of sustainable tourism.

The research programme commenced in 1993. Visits were subsequently made to each of the 11 national parks in England and Wales where senior level national park officers and private landowners within parks provided information through in-depth interviews. National and regional agencies responsible for countryside conservation, agriculture, recreation and tourism were also contacted.

LANDSCAPE CONSERVATION

Although there have recently been some changes to the legislation and agencies overseeing protected lands in the UK, the National Parks and Access to the Countryside Act 1949 dictated that one of the statutory roles of national parks in England and Wales was to preserve and enhance natural beauty. Under the same Act, a separate agency, the Nature Conservancy, was assigned the responsibility of nature conservation. The individual National Park Authorities have concerned themselves primarily with the protection of distinctive landscapes and areas of landscape beauty largely because of this administrative distinction between landscape and nature conservation. Since 1990, there has been an on-going attempt to bridge this conservation divide at both the broad policy level and on the level of management for the individual national parks. A Joint Statement on Nature Conservation in the National Parks has been signed by the relevant bodies and National Park Authorities. In addition, the more recent National Park Management Plans reflect the increased importance of wildlife and a more scientific approach to landscape and nature conservation (Swinnerton 1995a).

The British Experience

Partnership is essential because approximately 72 per cent of the total area within the 11 parks is privately owned. In addition, most of the land is used for agriculture. Consequently, agricultural policy and individual farmers have a profound effect on the landscape character of the national parks. In the past, agricultural intensification has been one of the greatest causes of landscape degradation in the parks. Since the late 1980s, a number of programmes have been introduced that involve a variety of partners including national agencies responsible for conservation, individual National Park Authorities, agricultural agencies and interest groups as well as individual farmers and landowners. The underlying purpose of these programmes has been to encourage farmers to farm in more environmentally responsible ways. The schemes range from advice and information to grants and management agreements. Recently, incentives and market-led approaches have been implemented such that landowners enter into financial agreements to provide specific products geared to landscape conservation and improving public access to the countryside (Swinnerton, 1995b).

SUSTAINABLE TOURISM

Although many of the national parks in England and Wales were important recreation and tourism destinations prior to their designation as protected areas, increasing numbers of visitors aroused concern over whether or not the essential character of these areas could be preserved. As a result, National Park Authorities' approach to tourism was one of caution and constraint. Recently, appropriate forms of tourism are being seen in a more positive light.

One of the best examples of this approach is the Dartmoor Area Tourism Initiative (DATI) which was established in 1991. The initiative has involved a variety of partners including national, regional and local agencies from the tourism industry, the Dartmoor National Park Authority and local government. One of the objectives of DATI has been to minimize the impact of visitor pressure within the park by raising the profile of areas outside its boundaries. Other important objectives are to ensure that tourism is based on the intrinsic attractions of the area and that it supports the conservation and enjoyment of these attractions (Swinnerton, in press). I am currently examining this programme within the context of the management objectives of protected landscapes.

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LEARNING FROM THE UK

In many instances, British National Park Authorities have become agents for change, identifying and implementing solutions to resource and tourism management problems. In addition, the dynamic qualities of the many partnerships allow policies to evolve over time. Similar partnerships in Canadian national parks are not only constructive for the management of existing national parks, but are likely to become even more important as means of establishing new parks and maintaining more effective buffer or transition areas around the parks. More specifically, the protected landscape approach would be particularly useful for parks such as Elk Island National Park which are surrounded by farmland and modified rural landscapes.

Canadian examples of protected landscapes include the Conservation Authority Areas in Ontario, selected regional parks in Saskatchewan and British Columbia, and the nature parks in Quebec. Clearly, the potential exists for widespread use of the protected landscape approach to establish partnerships which are integral parts of protected area management.

Dynamics of Alpine Larch

— continued from page 5 —

of water. In addition, their ability to avoid winter desiccation and abrasion explains why alpine larch are able to maintain an upright tree form in areas which would otherwise contain patchy, evergreen krummholtz or treeless, alpine meadows.

Larch at Healy Pass with fir krummholtz in the background

CURRENT RESEARCH

While previous research has provided a general ecological background on alpine larch and linked the deciduous habit of this species with its ability to exist at and above the normal timberline, little work has been done to identify what types of disturbance and microsite conditions are necessary for seedling establishment. The objectives of my work are: (1) to determine the role that natural disturbance and other environmental conditions play in the regeneration of alpine larch, and (2) to develop an empirically based model of the important factors affecting the regeneration success of alpine larch.

Forest communities tend to regenerate in response to disturbances. Any disturbance, whether it is a 1000 ha forest fire or the fall of a single mature tree, creates a break in the forest canopy and reduces competition for resources like light and nutrients, permitting germinating seedlings or suppressed saplings to grow.

Different tree species are adapted to utilizing different types and magnitudes of disturbance for regeneration. For example, Englemann spruce seedlings need relatively large areas which are clear from competing vegetation. Consequently, they commonly use areas cleared by fire for seedling recruitment. Englemann spruce have also been reported to regenerate within suitably large gaps opened by the wind-throw of older trees.

Because part of the alpine larch population exists within the subalpine forest, I am examining the response of larch in these areas to fire disturbance and other, smaller, gap-forming disturbances such as the wind-throw of one or a group of trees. My initial data suggests that, similar to spruce, larch use the large, gap-forming disturbance of fire to maintain a presence within the lower portion of their subalpine distribution. However, once the average spruce and fir canopy height surpasses roughly 20 m (the average maximum height of larch in these forests), the larch appear to be outcompeted, and disappear from the canopy.

As the average canopy height decreases towards timberline, larch start to utilize larger wind-throw gap areas to recruit seedlings. In these areas, the cover of the taller subalpine shrub communities (principally *Menziesia* and *Rhododendron*), is reduced, and the competition for light is not intense.

My future work will concentrate on detecting the effects of global warming on the alpine larch timberline tree community by looking at the ages of different tree species in different sites along this transition zone. This data may indicate whether one or all of the tree species are migrating. With the establishment of a number of permanent growth measurement sites, I hope not only to come to a better understanding of timberline tree colonization processes, but to provide information about both competitive interactions between tree species, and timberline tree regeneration dynamics in general.

ACKNOWLEDGMENTS

I would like to thank Parks Canada and the Arctic Institute of North America (Grant-in-Aid funding) for their support.

***Brendan Wilson** is a Ph. D. student with the Department of Biological Sciences at the University of Alberta. If you have any questions or comments, he can be reached by phone: (403) 492 - 4163; or by e-mail: wilsonb@gpu.srv.ualberta.ca*

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Pine Spruce Species and their hybrids

— continued from page 7 —

(Rajora and Dancik 1996). Using analysis of random amplified polymorphic DNA (RAPD) in the samples collected from allopatric regions of these two species, species-specific RAPD markers have been identified (Khasa and Dancik 1995). RAPD markers are being applied to determine both the pattern of population differentiation and the degree of hybridization, thereby clarifying the evolutionary relationships between white spruce and Engelmann spruce.

ACKNOWLEDGMENTS

The research was supported in part by Natural Sciences and Engineering Research Council of Canada grants (A0342 and F0001) to Bruce P. Dancik, a grant from the US Department of Agriculture (85-FSTY-9-0149) and Kentucky Agricultural Experiment Station research funds (KY0064) to David B. Wagner.

***Om P. Rajora** is an Assistant Professor, **Phambu D. Khasa** is a Postdoctoral Research Fellow, and **Bruce P. Dancik** is a Professor and Associate Vice-President (Academic) with the Department of Renewable Resources at the University of Alberta. For further information, please contact Om P. Rajora. Tel: (403) 492-4020, fax: (403) 492-4323, e-mail: om.rajora@ualberta.ca.*

Guest Lecturer Video Series

Calgary Regional Office of Parks Canada initiated a seminar series to inform staff about research projects, to showcase our staff's research projects, and to provide opportunities to exchange information about protected areas with other agencies. Speakers come from within Parks Canada, other federal and provincial government agancies and departments, and outside organizations. We are pleased to welcome guests at these seminars. Invitations are extended to the University of Calgary, Calgary Zoo, and Glenbow Museum. Each seminar is videotaped by a Heritage Communications specialist for future viewing. More videos are added to the series each month. We are always looking for speakers on topics related to science and park management and the many issues involved.

Oxman, Heather. March 15, 1995.
Education and Outreach - Connecting science with people.

Morgantini, Luigi. April 18, 1995.
Ya-Ha-Tinda – An Ecological Overview.

Herrero, Steven. May 1, 1995.
Grizzly Bear Patterns.

Leeson, Bruce and C. James Taylor, July 6, 1995.
National Parks: An American Legacy The birth and development of national parks in the United States.

Jadav, Chandra. October 4, 1995.
Wildlife, Flora and Fauna: Tourism in national parks in Tanzania and Kenya.

Perry, Bill. October 26, 1995.
Archaeological Sensitivity Modelling in Banff National Park.

Langemann, E. Gwyn and Martin Magne. December 8, 1995.
Archaeological Excavations: Housepits in Banff National Park.

Hodgins, Doug. January 18, 1996.
Science and Human Relations of the Banff-Bow Valley Study.

Bloemer, Steve. February 13, 1996.
Elk Link: Elk Island and Kentucky.

Taylor, C. James. March 6, 1996.
Raising the Poles at Sgan Gwaii.

*The videos are available, on loan, from **Geoff Lawrence**, head of A/V Media Services, at (403) 292-4501.*

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Heritage Rivers Have Stories to Tell

Touring Canada's Treasures

VOYAGES Canada's Heritage Rivers
edtited by Lynn Noel
illustrated by Hap Wilson

reviewed by Dianne Willott

VOYAGES Canada's Heritage Rivers takes a fascinating look at legend, history, geography and natural phenomena as they pertain to each of the 28 rivers which make up the Canadian Heritage Rivers System (CHRS). The CHRS is a national system designed to conserve Canada's river heritage. Since its inception in 1984, the CHRS has protected over 6000 km of rivers, including urban watersheds as well as wilderness water sources. With this collection of personal accounts of life and travel on the rivers, Lynn Noel shows us how the power and beauty of these national treasures have inspired native peoples, gold-rushers, anthropologists, poets, song-writers, outdoor enthusiasts and others over the centuries.

The book is organized geographically, meandering as across Canada as the rivers flow from the far Northwestern regions of the Yukon toward the Maritime provinces. There are five main sections within the text: "Raven: Heritage Rivers of the North," "Compass: Heritage Rivers of the West," "Pictograph: Heritage Rivers of the Interior," "Salmon: Heritage Rivers of the Atlantic", and "History and Future of Canada's River Heritage." Each of the first four sections features the experiences of modern-day river travelers, interspersed with passages from river legends, historical records and explorers' diaries from early expeditions to the area. The fifth section, "History and Future of Canada's River Heritage," emphasizes the "watershed approach" to conservation which views flowing water and ice as phenomena which clearly illustrate the inter-connectedness of ecosystems, and help to identify areas in need of protection.

For each river, the personal experiences and stories are put into historical and geographical contexts with information and updates an its nomination and designation to the CHRS, hand-illustrated maps which show historical and geographical landmarks, photographs and artwork. Entire works and excerpts from poets and songwriters including Stan Rogers, Gordon Lightfoot and Robert Frost, as well as legends from many native peoples including the Haida, Micmac, Ojibwa and Kwitchia Gwitch'in, provide the emotional and spiritual contexts.

By combining all of these different components, Noel provides the reader with a collection of unique experiences which show not only the wide range of rivers in the CHRS, but the diversity of Canadian cultural experiences inspired by, and depending upon our powerful waterways. *VOYAGES Canada's Heritage Rivers* reminds us that rivers have shaped Canadian people as much as they have the Canadian landscape and they are certainly treasures worthy of protection.

Dianne Willott *is Production Editor of Research Links. For further information, please call (403) 221-3210.*

VOYAGES Canada's Heritage Rivers *is edited by Lynn Noel, and illustrated by Hap Wilson. Published by Breakwater, St. John's NF (1995).*

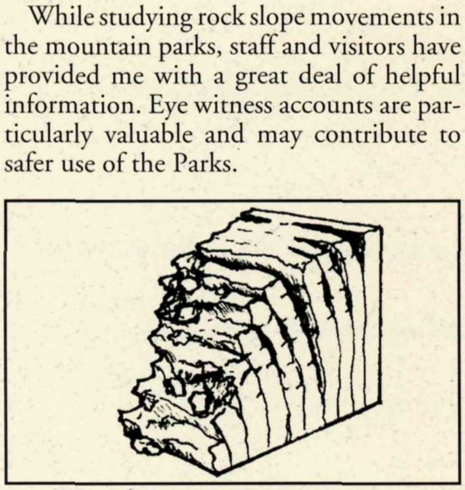
Assessing the Risks of Rock Slides

— continued from page 4 —

enced a complex rock topple rock slide which ran up the other side of the valley (Hu and Cruden 1992). This occurrence suggests that sites below steep anaclinal slopes also need careful examination.

THE FUTURE

While studying rock slope movements in the mountain parks, staff and visitors have provided me with a great deal of helpful information. Eye witness accounts are particularly valuable and may contribute to safer use of the Parks.



Rock toppling

D. M. Cruden *is a Professor in the Department of Civil Engineering at the University of Alberta, Edmonton, AB, T6G 2G7. Please write to him or contact him by e-mail: dmcruden@civil.ualberta.ca if you have any information regarding rock movements.*

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PODIUM

Critical Issues for the Next Century:

Two Parks Canada Experts Share Their Views

POINT

Charles Blyth

There are three critical issues facing parks as we move into the next century: 1) the incredible rate of human population growth, 2) our rapidly changing technology, and 3) the global economic movement away from multifaceted responsibilities (to employees, management, the board of directors, shareholders, the community, the environment, and the nation) toward a unilateral focus on the shareholder. Together, the global population times per capita consumption times an index for technology relates what can be called the ecological load on our national parks. The factor which most affects the dynamics of this ecological load on our parks is, of course, technological change. The wave of technological change from nomadic to agricultural living took thousands of years, and the change from agricultural to industrial living, hundreds of years, while changes associated with the information era are expected to take only decades. From the perspective of parks, this rapid rate of change raises issues about our ecosystem management capacity, especially in the context of today's global trade and tourism.

What can we do in national parks? First, I believe that we should pursue changes in technology. This must include bioengineering advances with an emphasis on biological restoration. We must also make real moves toward alternative materials and energy conservation. Second, we have to change the way we think in order to move us into an era of global ecoconsciousness. Strategically, we must balance the maximization of revenue with the explicit priority to maintain ecological integrity. This will require a major change in thinking because most of today's business plans are driven by short term, budget-cutting realities. Two questions we need to consider and incorporate into our plans are: 1) To what degree is business, in particular tourism, sustainable in National Parks? and, 2) What must we do to sustain the current levels of tourism and business while reducing the ecological load? To answer these questions and change as we are required to do by changes in technology, it is clear that research in national parks needs a new direction.

We have the National Parks Act and scores of national operational policies and guidelines that will allow us to proceed in a new direction. What is needed is a real commitment from all of us who work in the parks, from the researcher who works in the field to the top management in the administration office. We need to believe that parks can serve a role in reducing the ecological load that people place on our natural systems. If we take this belief to work every day, and use it in every decision, we can enable national parks to succeed in the face of increasing ecological loading.

***Charles Blyth** is the Ecosystem Management Specialist for Elk Island National Park. Tel: (403) 992-2972.*

COUNTERPOINT

Rod Heitzmann

Humankind has been altering, modifying, or responding to ecology and the environment for thousands of years. Throughout it all, the Earth has responded with a variety of ways resulting in species extinction, species diversification and climate change. Charles Blyth identifies three critical issues facing parks in the next century: human population growth, rapidly changing technology, and the movement of a global economy toward corporate profits. These issues, and others, will challenge managers of protected areas as never before.

What strategies should be pursued by those concerned with the welfare of national parks and other protected areas? First, we must continue to enhance our efforts to ensure biodiversity. This must go beyond merely protecting areas from human trampling and poaching. We must continue to intervene actively in parks because they are only fragments of ecosystems, and because past management practices have inhibited natural processes and traditional human actions. Protected areas must ensure that mosaics of habitats continue to exist to provide suitable niches for a wide range of species and populations. To do this, we need not necessarily incorporate "high-tech" solutions, but we do need the desire to make well informed, carefully thought out decisions about natural system management. Prescribed burning to re-establish forests or maintain grasslands, denying recreational access to critical animal habitats and defining boundaries between human occupied areas and wilderness are some techniques which can and should be used effectively in the future. We cannot continue the myth that national parks are unmanaged "natural" areas. To reduce the "ecological load," more interventions will be necessary.

As we develop new strategies, and make better use of existing ones, we must enhance our efforts to effectively communicate the aesthetic and evolutionary importance of biodiversity in our world. Public support is of vital importance. Visitors to our parks may arrive as sight seers, skiers or campers, but they should leave our parks as supporters of protected areas. Through this support, it is possible to counter the growing emphasis on business and profits.

The world wide issues and problems that will be faced in the next century are monumental. The maintenance and expansion of protected areas may ultimately be essential to the continuation of our planet through informed management practices founded in ecosystem diversity and sustainability.

***Rod Heitzmann** is an archaeologist with Parks Canada's Alberta Regional Office. Tel: (403) 292-4694.*

MEETINGS OF INTEREST

April 10-11, 1996

Access Management: Understanding the Issues. Westin Hotel, Calgary, AB. The object of this conference is to provide a contemporary forum for all stakeholders to share information, discuss and debate issues surrounding the management of access to public lands. Experts from oil and gas, forestry, mining, eco-tourism, land-use planning, wildlife research, policy and law, and conservation biology will be among those making presentations. Contact Bonnie Holtby, Alberta Society of Professional Biologists. Tel: (403) 434-5765, e-mail: aspb@ccinet.ab.ca.

April 15–17, 1996

Acidifying Emissions in Alberta: Applying National and International Expertise to the Alberta Situation. Red Deer, AB. This symposium will bring scientists, managers, and other stakeholders together to explore and discuss the health and environmental effects of acidifying and related air emissions. The goal of the symposium is to place the Alberta situation in context with research and management experiences in other regions and countries. Contact the Clean Air Strategic Alliances, 6th Floor, Standard Life Centre, 10405 Jasper Avenue, Edmonton, AB, T5J 3N4. Tel: (403) 427-9793, fax: (403) 422-3127, e-mail: casa@ccinet.ab.ca.

May 1-4, 1996

Forest - Fish Conference: Land Management Practices Affecting Aquatic Ecosystems. Marlborough Inn and Convention Centre, Calgary, AB. Through oral presentations and a poster session, this conference aims to increase awareness of management solutions that improve watershed protection and minimize the impacts of forest land-use activities on aquatic environments, by facilitating the exchange of information between forest management and aquatic resource experts. Contact Kerry Brewin, Steering Committee, Forest - Fish Conference. Tel: (403) 221-8369.

May 18–23, 1996

The 6th International Symposium on Society and Resource Management. University Park, PA. The 1996 conference will focus on a better integration of social and natural sciences in addressing resource and environmental issues. Contact A.E. Luloff, 11 Armsby Building, University Park, PA, 16802. Tel: (814) 863-0401.

August 20-24, 1996

Second World Congress on the Preservation and Conservation of Natural History Collections. Cambridge, UK. The congress, structured around discussion sessions and workshops, will focus on providing practical solutions for the continued development and support of natural science collections around the world. Contact the Administrator, World Congress, Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge, CB2 3EQ, UK. Tel: (44) 123-33-3421, fax: (44) 123-33-3450.

September 8–13, 1996

Sustaining Ecosystems and People in Temperate and Boreal Forests. Victoria, BC. This international conference, focused on integrating conservation of biological diversity with social and economic goals, intends to promote understanding of sustainability issues and to emphasize constructive, long-term solutions needed to sustain biological diversity of native forests and the human communities they support. Contact Connections Victoria Ltd., P. O. Box 40046, Victoria, BC, V8W 3N3. Tel: (604) 382-0332, fax: (604) 382-2076, e-mail: convic@octonet.com.

September 29-October 1, 1996

Caring for Home Place: Protected Areas and Landscape Ecology. Regina, SK. The theme of this joint national conference of the Canadian Council on Ecological Areas (CCEA) and the Canadian Society for Landscape Ecology and Management (CSLEM), will go beyond traditional perspectives on protected areas to embrace the idea of sustaining "healthy" ecosystems in which biophysical, social, cultural, and economic considerations are in close agreement. Contact CCEA/CSLEM "Home Place" Conference 96, c/o Canadian Plains Research Centre, University of Regina, Regina, Saskatchewan, S4S 0A2. Tel: (306) 585-4758, fax: (306) 585-4699, e-mail: cprc@max.cc.uregina.ca.