Research Links
A Forum for Natural, Cultural and Social Studies

Square hooks for exotic brooks:

experimental gillnet removal of brook trout from Bighorn Lake, Banff National Park

Brian R. Parker and
David W. Schindler

Figure 1.

Views of Bighorn Lake, Banff National Park, AB

This lake was stocked with brook trout in 1965 and 1966.

Numerous naturally fishless alpine lakes in the mountain National Parks were stocked with non-native trout species earlier this century in an effort to increase backcountry angling opportunities for park visitors. Unfortunately, the introduced trout frequently damaged the native invertebrate communities of stocked lakes (Parker and Schindler 1995) while providing only marginal fisheries. With a change in public attitudes (Rahel 1997) and parks policy, trout stocking ceased and the lake communities were left to evolve without further management. Some stocked lakes have failed to return to their pristine condition, either because the introduced trout populations reproduced naturally or, if the introductions failed, native species of aquatic invertebrates had been extirpated.

To determine if the communities of stocked lakes can be returned to their fishless condition, we have been conducting experimental restorations of lakes whose communities were damaged by fish stocking. In 1997, we commenced an experimental gillnet removal of brook trout *(Salvelinus fontinalis)* from Bighorn Lake, Banff National Park (BNP), which we describe below. Gillnetting, if effective, may constitute a more ecologically benign restoration method to remove fish from stocked lakes than the use of piscicides (fish poisons), which also kill non-target organisms.

Bighorn Lake, a fishless, 2.1 ha, 9 m deep alpine cirque lake (2347 m asl) was stocked with 2000 fingerling brook trout in both 1965 and 1966. In 1977, small emaciated trout were captured during test netting. All of the fish were either 13 or 14 years old and thus survivors of the original stocking (Anderson and Donald 1978). The trout population was not expected to persist beyond the mid-1980's because of apparent reproductive failure. Assuming that the cessation of warden fishing trips to Bighorn Lake after 1982 (based on Windy and Cuthead Cabin log entries) reflected the demise of the brook trout, we were surprised when our re-surveys of Bighorn Lake between 1991 and 1996 revealed that numerous trout were present and that they were successfully reproducing.

The brook trout dramatically altered the original planktonic community of Bighorn Lake by eliminating two crustacean species: *Hesperodiaptomus arcticus* and *Daphnia middendorffiana*. In response, rotifer densities increased and species composition of both algae and rotifers changed, and a previously unreported species of copepod, *Diacyclops bicuspidatus*, appeared. Predation by trout caused the biomass of planktonic crustaceans to fall to among the lowest reported for surveyed lakes in BNP.

After considering the marginal quality of the fishery (estimated annual yield = 25 g to 130 g trout; Anderson and Donald 1978) relative to the ecological damage caused by the introduction, we commenced removal of the brook trout from Bighorn Lake in July, 1997, with the assistance of the BNP Warden Service.

Eight hundred metres of mixed-mesh gillnets (25-100 mm stretched mesh) were

- continued on page 7 -

Research Links

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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. 24

EDITORIAL

Parks Canada has long been responsible for managing national parks and national historic sites for the benefit of Canadians. This means we must maintain the ecological integrity of our parks and ensure the commemorative integrity of our sites. Research plays a principal role in providing the knowledge we need to make informed decisions toward ecosystem restoration and cultural resource management.

As Parks Canada's knowledge base accumulates more accurate information through research, our ability to make good decisions to achieve our mandate should improve. As many of the articles in this issue of *Research Links* reveal, we are finding that our long history of managing parks and sites has left us with impacts as difficult to understand as they are to reverse.

Brian Parker's article on removing exotic fish from a stocked lake is one example of how complex restoration can be. Removing the fish is only the first step in the process. It is also important to understand invertebrate communities in fishless lakes and methods for re-introducing invertebrates to make restoration efforts successful.

New research and perspectives are resulting in a variety of tools for decision-making. With the aid of cumulative effects assessments (CEAs), we are learning to assess the impacts of proposals, including our own management actions. David Hems and Paul Downie look at the "nibbling" effects of our own restoration and development actions on the condition of a national historic site. Suzanne Therrien-Richards offers a solution in her piece on linking CEA with adaptive management, and Graham MacDonald presents a perspective that challenges common views on heritage his review of David Lowenthal's latest book.

CEA can also be applied toward preserving ecological integrity. Shawn Cardiff demonstrates how finding meaningful indicators can be difficult in his article about the complex and sensitive Three Valley Confluence area in Jasper National Park. Three Valley Confluence is also the site of George Mercer's research, which incorporates data from GIS and infrared cameras to compare human and wildlife use of trails to monitor cumulative impacts. John Woods and Curtis Strobeck also show the importance of new research tools and approaches as they combine molecular biology and field ecology in a powerful new tool for environmental assessment. Techniques such as these are needed to provide quality information so managers can make better decisions.

In closing, we should not feel limited to research what may appear to be our most pressing issues. Through their studies of the impacts of depositional nitrogen in 6 western national parks, Martin Köchy and Scott Wilson inspire us to think and act on larger scales to understand how human activity changes ecosystems.

Enjoy the new information, food for thought and creative new ideas in this issue of *Research Links*.

Richard Leonard
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Release of Report on

Ecological Integrity of National Parks

The report from the ecological integrity (EI) panel appointed by the Minister to examine the ecological integrity of Canada's national parks was made public on March 23, 2000.

The Minister indicated that she appointed the panel "after the lessons of the Banff-Bow Valley Study and subsequent strong actions taken in the Banff Community Plan and the Banff National Park Management Plan." She accepted the recommendations of the panel and identified immediate actions that Parks Canada would take, including:

- accelerating the legal declaration of wilderness areas in the mountain national parks
- improving relationships with aboriginal people
- working collaboratively with managers of adjacent lands and provincial governments
- working with those who market and use national parks to ensure understanding of the ecological integrity mandate
- revising the Guide for Management Planning to require a 5 year State of the Park Report for each park (which will link into the national SOP report) and an annual management plan implementation report
- ensuring that the maintenance of ecological integrity is the primary consideration in Parks Canada's assessment of development
- establishing a position of Executive Director for Ecological Integrity to be a full member of the Parks Canada Executive Board. Nik Lopoukhine (former Director, National Resources Branch, Parks Canada, National Office), currently holds this position.
- ensuring adequate scientific advice is provided in decision making
- developing a national training and orientation program in ecological integrity for all staff and partners.

The Minister indicated that a more detailed strategy for Parks Canada in response to the recommendations will be available in the fall, and will be discussed at the first Parks Canada Agency biennial public forum in October, 2000.

Information about the EI panel report is available online at: http://www.parkscanada.gc.ca/EI-IE/index_e.htm (in French at .... index_f.htm) The entire document can be viewed in PDF format at: http://www.parkscanada.gc.ca/EI-IE/report.htm

Adapted from a staff information piece by Jillian Roulet, Senior Poilcy Advisor, Mountain National Parks, Banff

FEEDBACK

"I would like to clarify a few misconceptions regarding the Treasury Board Heritage Buildings Policy put forward in the recently published article titled "Built Heritage Resource Description and Analysis [C.J. Taylor, *Research Links* 8[1] — Spring 2000]."

As stated in the 1998 Treasury Board Heritage Buildings Policy, the policy applies to all buildings administered by the federal government. Consequently, the policy does apply to buildings 40 years of age or older on properties leased by the federal government.

The evaluation process and criteria used by the Federal Heritage Buildings Review Office, which assists federal departments in the implementation of the Treasury Board Heritage Buildings Policy, takes into consideration the local context of the building being examined (under the criteria of historical associations and environmental values).

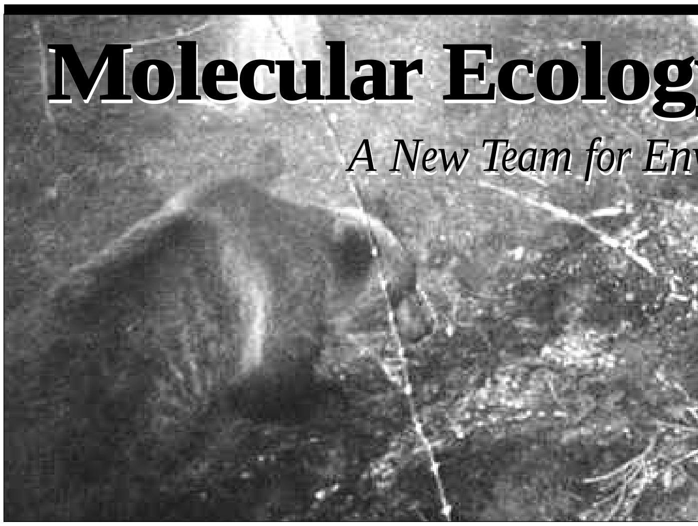
Finally, the FHBRO evaluation process was designed to do what the policy calls for — the evaluation of federal buildings (not complexes, landscapes or other built structures) in order to determine their heritage values. The criteria used have proven their value with time and are used throughout the federal government as well as by other heritage organisations."

"...I wish to take this opportunity to congratulate you and your team for a very worthwhile journal."

—Robert Moreau, FHBRO Manager

Molecular Ecology and Field Biology

A New Team for Environmental Assessments



A grizzly bear enters a barbed-wire hair trap in Glacier National Park.

West Slopes Bear Research Photo

John G. Woods and Curtis Strobeck

Some of the most important questions in environmental assessment appear deceptively simple. Is an animal found in the project area? How many live there? Are their numbers increasing or decreasing? And, after the project is on the ground, did the mitigation work? If your focus is a rare animal, then by definition it may be hard to detect and you may be limited to the use of non-invasive methods. Fortunately, advances in the emerging field of "molecular ecology" (the use of molecular analysis techniques to study ecological questions) combined with innovations in field methods, are providing a new generation of data to help answer these difficult questions (Haig 1998, Palsbøll 1999, Taberlet *et al*. 1999, Woods *et al.* 1999).

Since 1994, our West Slopes Bear Research team has been developing methods to detect and monitor grizzly (*Ursus arctos*) and black bears (*Ursus americanus*) in a 5,000+ km^2 area on the western slopes of the Rocky Mountains and the eastern slopes of the Columbia Mountains (including most of Glacier and Yoho National Parks). Current research builds on our early success identifying the mothers (and in some cases, the fathers) of cub black bears from the DNA contained in a few hairs. We have been seeking ways to gather and analyze genetic data to address conservation issues related to bear management in eastern interior of British Columbia (Woods and McLellan 2000).

DNA is found in 2 organelles in most mammalian cells: mitochondrial DNA (mtDNA) in the mitochondria and nuclear DNA (nDNA) in the nucleus. All mammalian cells contain numerous mitochondria and most cells contain a nucleus. All mammals inherit their mtDNA from only their mothers. nDNA is derived from both parents (one copy from each parent). mtDNA is routinely used to distinguish animal species. For example, black bears are easily separated from grizzly bears based on mtDNA analysis (Paetkau and Strobeck 1996). In practice, nDNA is most useful for DNA fingerprinting.

Preliminary work on the variability of nDNA in bears in the West Slopes study area showed that we had a high likelihood of identifying individuals from their genetic fingerprints (Paetkau and Strobeck 1996, Paetkau *et al.* 1998). This is done by measuring variations in length of "microsatellites," which are specific, hypervariable non-coding regions of nDNA (Figure 1). Each microsatellite can come in several forms (lengths) and each of these forms is called an allele. If a microsatellite does not have several alleles, it is not useful in genetic fingerprinting. The greater the number of alleles, the better the resolution of the individual DNA fingerprint.

Since 1 copy of the microsatellite comes from a bear's mother, and 1 from its father, each microsatellite can be represented by a pair of numbers representing combination of alleles derived from the bear's parents. These can either be the same (homozygous, e.g., 194–194) or different (heterozygous, e.g., 184–194). The fingerprint then becomes a series of numbers related to each of the microsatellites you examine. In a population with little genetic variation, you may need to look at a great number of microsatellites to obtain a unique fingerprint for an individual. These patterns of microsatellites can also be used to determine the relationship between bears. Obviously, any candidate parent bear must share at least 1 allele at each microsatellite position with their young. And similarly, genotypes of siblings must be derived from the alleles available from their parents only (and not from the entire bear gene pool).

DNA fingerprints can act as unique "tags" for individual bears. These genetic tags have several advantages over physical markers (Palsbøll 1999). Each nucleated cell in an animal's body carries the same DNA fingerprint and the tag remains unchanged throughout the animal's life. Unlike physical tags, DNA tags can't become unreadable or lost. And most importantly for rare or illusive species, it is possible to obtain DNA non-invasively from free-ranging animals. Examples of genetic tag sources that have been used from free-ranging animals include sloughed skin from humpback whales (*Megaptera novaeangliae*) (Palsbøll *et al.* 1997), faeces from coyotes (*Canis latrans*) (Kohn *et al.* 1999), and shed hair from chimpanzee (*Pan troglodytes*) nests (Morin *et al*. 1994).

Taberlet *et al.* (1997) illustrated the potential of DNA in assessing the status of a population in their study of the rare Pyrenean brown bear (the European form of the grizzly bear found in France). Previous to this genetics-based work, there was considerable uncertainty over both the number and sexes of the bears left. Capturing and applying marks was too great a risk considering the few bears remaining (thought to be 8–10). By analyzing the DNA contained in faeces

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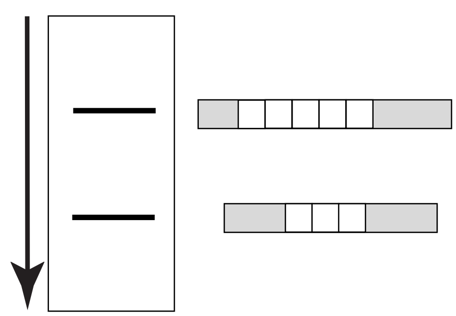

Figure 1. Nuclear DNA strands from an individual illustrating 2 alleles for a specific microsatellite. Alleles are identified by differences in size due to the number of tandem repeats (white boxes) of DNA they contain. Since smaller pieces of DNA run faster down a gel when subjected to an electric current, the 2 alleles can be distinguished.

FOREST EXPANSION IN WESTERN CANADA

Martin Köchy and Scott Wilson

Forest expansion in North America since colonization by Europeans has usually been attributed to reduced grazing by bison and elimination of wild fires (Campbell *et al.* 1994, Archer 1996). While these may be necessary conditions for forest expansion, the increase of emissions of nitrogenous compounds with industrialization may have accelerated forest expansion. Forest expansion can be a cause for concern in parks with a small proportion of grassland (Vetsch 1987, Bork *et al.* 1997, Schwarz and Wein 1997). The loss of grassland means that biodiversity is reduced within the protected area and in surrounding areas, because many plants and animals have no refuge in a managed agricultural or forestry landscape. We measured nitrogen deposition, available soil nitrogen and forest expansion in 6 national parks to learn more about the pattern of nitrogen deposition in the prairie provinces and the effect of this deposition on plant community dynamics (Köchy 1999).

Nitrogen deposition is the single most important agent of vegetation change in European nature reserves (Vitousek *et al.* 1997). Nitrogen is normally a nutrient in short supply. Its scarcity is limiting tree growth more than it does grass growth. When nitrogen is deposited from the atmosphere with rain and dust and added to a nitrogen-poor ecosystem, vegetation height increases, species composition changes and diversity decreases. Fossil fuel use in far-away cities can add several times the natural amounts of nitrogen to remote ecosystems (Vitousek *et al.* 1997). Atmospheric nitrogenous compounds in western Canada have 3 main sources: industrial processes (39%) (mostly from the petrochemical sector), vehicle exhaust (35%), and fuel combustion for heat and power generation (16%) (Environment Canada 1998).

METHODS

We measured nitrogen deposition and available soil nitrogen in 6 national parks in western Canada (Figure 1). The parks with their surrounding landscape varied in population density which is an index for anthropogenic sources of atmospheric nitrogenous compounds. All parks include forests and grasslands.

In all parks, aspen (*Populus tremuloides*) is the expanding tree species. Grasslands in the parks are of mixed-prairie or fescue-prairie type. Grassland in Elk Island National Park (EINP), however, is dominated by Kentucky blue grass (*Poa pratensis*) and marsh reed grass (*Calamagrostis canadensis*). EINP vegetation is affected by prescribed burns and is grazed by high densities of bison (*Bison bison*), moose (*Alces alces*), deer (*Odocoileus* spp.) and elk (*Cervus elaphus*).

For 2 years, we measured nitrogen deposition and available soil nitrogen with ion-exchange resin bags (3 cm x 3 cm) 4 times per year at at least 10 sites in each park (Köchy 1999). We chose the resin bag method because surface and uptake characteristics of resin resemble those of leaves or roots. Further, soil moisture conditions presumably affect nitrogen collection by resin bags in a similar way as it would affect nitrogen uptake by roots. As a result, measurements with resin bags are not directly comparable to commonly used meteorological methods. Those methods usually measure only nitrogen contained in rain and estimate nitrogen deposited with dust.

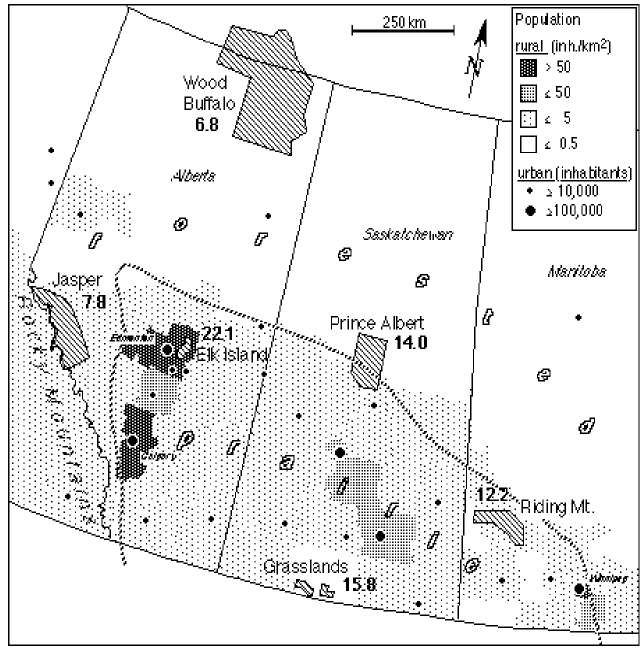

Figure 1. Annual deposition of nitrogen (kg/ha/y) and population density in western Canada.

We calculated forest expansion in all parks from aerial photographs from 1930 to 1995 (Köchy 1999). We tested with analyses of variance and linear regressions whether forest expansion rates were related to nitrogen deposition or climate (annual temperature, annual precipitation, and long-term changes of temperature and precipitation).

RESULTS AND DISCUSSION

Atmospheric deposition of nitrogen in western Canada was higher in densely populated than in sparsely populated regions (Figure 1), presumably reflecting higher nitrogen emissions from industry and transportation. The highest rate of nitrogen deposition was observed in EINP, 50 km east of Edmonton with emissions of 37-268 kg nitrogen/ha/y. For comparison, in northern Alberta emissions are <0.2 kg nitrogen/ha/y (Cheng 1994). Comparison of the ^{15}N isotope content in vegetation in EINP and Jasper National Park suggested that high rates of nitrogen deposition at EINP are related to combustion processes in industry and traffic (Köchy 1999).

Elevated deposition rates in Grasslands, Prince Albert, and Riding Mountain (Figure 1) may be caused by the prevailing westerly and northwesterly winds, carrying nitrogen particles from sources in Edmonton and Calgary and from oil refineries in the Lloyminster area west of Prince Albert (Figure 1).

Available soil nitrogen in the 4 parks with high rates of nitrogen deposition was higher than in the 2 parks with low rates of nitrogen deposition (Figure 2). Temporal and spatial variation was large (Köchy 1999), suggesting that nitrogen deposition should be measured on the scale of years and provinces to detect significant and meaningful trends. Available soil nitrogen was correlated with deposited nitrogen across all parks (Köchy 1999), presumably because most of the deposited nitrogen enters the soil by stemflow and throughfall. Vegetation types, fire history, grazing and soil

- continued on page 6 -

FOREST EXPANSION IN WESTERN CANADA

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types might affect nitrogen deposition and available soil nitrogen directly or indirectly through changes in deposition surfaces or nitrogen uptake. However, close inspection of deposition and soil nitrogen patterns at EINP revealed that temporal variation was generally largest (Köchy 1999).

Forests in high-deposition parks expanded up to ten times faster than forests in low-deposition parks (Figure 3). Trees and shrubs that invade grassland take up more soil nitrogen than grasses can and therefore should benefit most from nitrogen fertilization by deposition. Fertilization also increases water-use efficiency of the woody invaders (Bert *et al.* 1997) which may enable them to invade temperate grasslands restricted to dry, coarsely textured soils. Fertilization may accelerate nitrogen cycling (Högbom and Högberg 1991, Berendse 1994) which decreases competition for nitrogen and increases competition for light (Reynolds and Pacala 1993). This may favour tall or fast growing trees (Nilsson and Hallgren 1993). In addition, the spatial positioning of tree leaves along branches high above the ground allows them to filter more nitrogen from the air than grasses can. The higher deposition rates would result in a self-maintaining positive feedback (Wilson 1998). Grasslands National Park forests did not expand despite high nitrogen deposition. This park lies outside the forest biome and its aspen forests are restricted to a few river valleys. Aspen has no particular adaptation to tolerate water deficits, therefore forest expansion in Grasslands may be more limited by moisture than by nitrogen.

Across all parks, forest expansion was not related to climate (Köchy 1999). It was, however, related to precipitation in the 3 parks with annual precipitation <420 mm (Figure 4). Above this threshold, forest expansion seemed more related to nitrogen deposition rates. The inclusion of more sites with a wider range of nitrogen deposition and annual precipitation could clarify whether annual precipitation and deposition interact in their effects on forest expansion.

Before industrialization, the expansion of shrubs and trees in arid grasslands used to be checked by recurrent wild fires and bison browsing on the shrubs and trees (Archer 1996, Bork *et al.* 1997). Therefore, it has been suggested that forest invasion can be reversed by increasing grazing and fire frequencies to pre-industrial levels. Our study suggests that this may be ineffective, because the accelerating effect of increased nitrogen deposition has not been considered. To preserve dry grasslands in western national parks, future research should test the correlation between nitrogen deposition and forest invasion and establish necessary levels of grazing and burning. In addition, parks should lobby governments at all levels to reduce nitrogen emissions.

ACKNOWLEDGEMENTS

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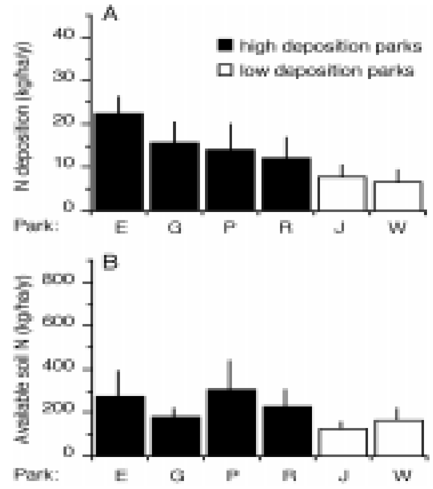

Figure. 2. Deposition of atmospheric nitrogen (A) and available soil N (B) in six western Canadian national parks (E: Elk Island, G: Grasslands, J: Jasper, P: Prince Albert, R: Riding Mountain, W: Wood Buffalo). Bars represent means ± SE of 10 sites times 8 measurement periods.

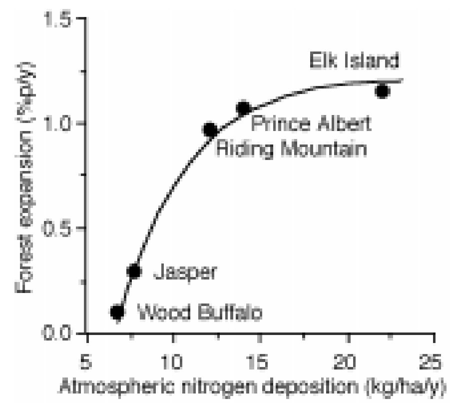

Figure 3. Expansion of forest in relation to nitrogen deposition (%p/y: annual increase of %forest area relative to total [grassland+forest] area in percentage points).

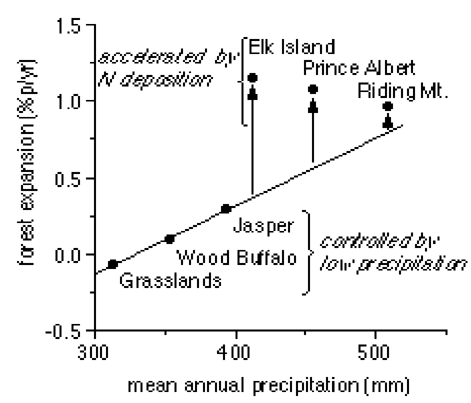

Figure 4. Forest expansion in relation to annual precipitation (%p/y: see Figure 2).

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Square hooks for exotic brooks

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Figure 2. Checking gill nets.

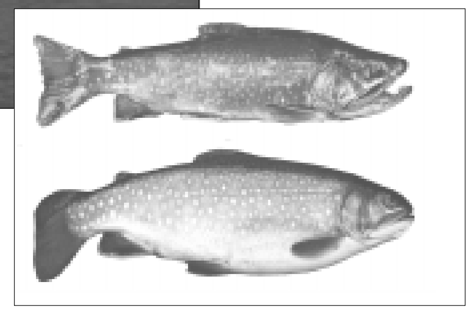

Figure 3. Bighorn Lake brook trout (top panel) were emaciated and little more than half the weight of similar sized brook trout from nearby Wigmore Pond, BNP (bottom panel).

set in Bighorn Lake on July 7, 1997, and fished for 10 days, after which approximately 400 m of gillnet were removed. For the first two weeks of gillnetting, nets were checked daily or every other day. Fish removal is ongoing and we continue to fish 250-400 m, checking the nets approximately monthly during ice-free seasons. Nets are left to fish through the winter (three winter seasons to date). In 1997, we electroshocked the shoreline in an attempt to remove juvenile trout that were too small to gillnet. Unfortunately, this method proved ineffective and was discontinued. Biological data and samples, including length, weight, otoliths, tissue samples and stomach contents were collected from captured trout. Dissected trout were considered unfit for human consumption, so unused portions were donated as bait for bear studies (luring bears to barbed wire stations used to obtain hair samples — see Woods and Strobeck, p. 4 in this issue).

One hundred and thirteen trout were captured in the first 2 days of gillnetting. Catch rates fell dramatically during the following 3 days, after which we captured less than 2 fish per day. The decline can be attributed to 2 factors: 1) the decreasing number of trout; and, 2) gillnet avoidance by the trout. David Donald has observed that trout start to avoid gillnets within a few hours of nets being set and suggests that they might have been better deployed intermittently, as practiced by Knapp and Matthews (1998). An additional 79 trout were captured through October, 1997.

Limited spawning may have occurred in October, 1997; the remains of 13 mature and 6 juvenile trout were removed from the gillnets in June, 1998. Only 1 trout, a juvenile, was captured during the remainder of the summer, therefore we believe we prevented spawning in the fall of 1998. Brook trout catch increased in 1999: 48 juveniles of the 1996 cohort were removed by mid-July. No further trout were caught through to early October. In 2000, we should capture any juveniles spawned in 1997.

The length and age at which Bighorn Lake brook trout mature (approximately 250 mm, age 4 or 5) has not fallen since gillnetting began, contrary to observations in other exploited populations. If size and age at maturity for the 1996 and/or 1997 cohort fell to 150 mm length and age 2, gillnet removal would become difficult because these individuals would be vulnerable to the nets for perhaps only 2-3 months prior to spawning. Currently, the trout are "catchable" for at least 2 years before they mature.

To date, 260 brook trout, weighing approximately 50 kg in aggregate, have been removed from Bighorn Lake. More than 9,000 net nights of fishing effort (average net length = 35 m) have been applied. The cost of the fish removal has been modest. By the end of the experiment, approximately $10,000 of helicopter time and gillnets will have been purchased. In addition, between 12 and 30 staff days have been required to monitor the nets each year. In terms of incidental ecological costs, a single Lesser Scaup *(Aythya affinis)* that died after becoming entangled in a gillnet was the only unintended mortality. Also, on one occasion, bears or other animals scavenged several dead fish after unauthorized persons removed four gillnets from the lake.

We will continue gillnetting until the fall of 2002, by which time we hope to have failed to catch trout for more than a full year; our benchmark for successful removal. A return visit to the lake a decade later will be required to confirm the success of the experiment.

The invertebrate community of Bighorn Lake is beginning to recover; *Daphnia* reappeared in 1998 and crustacean biomass has increased more than 50-fold. However, to fully restore Bighorn Lake to its pristine condition, *H. arcticus* will have to be reintroduced to the lake's waters. Our work on nearby lakes suggests that after being absent for more than 30 years this species has been permanently extirpated (Parker *et al.* 1996). We successfully reintroduced *H. arcticus* to Snowflake Lake, BNP, in 1992 and restored the lake invertebrate community to its original condition (McNaught et al. 1999). With respect to invertebrate restoration, it is important to establish and protect a series of "benchmark" aquatic systems in the parks. Benchmark systems provide reference data with which to compare stocked or otherwise impacted lakes, and seed stock for restoring extirpated species.

Given the effort employed to eliminate trout from Bighorn Lake, we speculate that removal of non-native trout with gillnets alone may be impractical for many larger park lakes. Intensive commercial fishing eliminated lake trout from Lesser Slave and Touchwood Lakes in Alberta earlier this century, but more than a decade was required in both cases. If the restoration of larger lakes is proposed, alternate methods of fish removal including, but not limited to, electroshocking, trapnetting, destroying spawning grounds, lake drawdown and/or the application of piscicides should be given consideration in addition to, or in replacement of, gillnets. The use of piscicides or lake drawdown will be highly controversial, but their use may be the most practical methods for attempting to remove fish from certain lakes. National parks managers have previously used chemical agents to eradicate native fish from numerous lakes prior to stocking with non-native sport fish, although with mixed success.

The Bighorn Lake restoration work does not address several important issues associated with the removal of non-native

- continued on page 14 -

Molecular Ecology and Field Biology

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and shed hairs, and by taking field measurements of bear tracks, they identified 5 bears (after 1993) including 3 adult males, 1 yearling male, and 1 adult female. Moreover, by plotting the locations where they found unique genotypes, they were able to draw home range maps for individuals. These data allowed the authors to make important conclusions on the likely future of this tiny population.

We designed a series of trials in 1996–98 to trap bear hair from free-ranging bears by attracting them to small barbed-wire enclosures scented with the smell of rotten meat and fish (Woods *et al.* 1999). Our hope was that bears would investigate the enclosure, pass under the barbed-wire, and leave a sample of hair that we would later collect (see photo on page 4). By repeating the process several times across the study area, we would build up a collection of hairs from which we could extract mtDNA to identify bear species and nDNA to identify individuals. Using Y-chromosome specific tests, we also could identify the sex for most individuals (only male mammals have a Y-chromosome). By analyzing the proportions of repeat visits for individual bears to new bears encountered each session, we would then be able to analyze our data as a mark-recapture experiment and develop an estimate of bear numbers.

In most of our initial West Slopes work, we choose 6 microsatellites that had 4–8 alleles each for grizzlies and 6–13 alleles each for black bears (Paetkau *et al.* 1998). In contrast, the remaining Pyrenean brown bears had much less genetic variability. Taberlet et al. looked at 24 microsatellites and found 18 with only 2 alleles each an additional 6 microsatellites with no variability (i.e., only 1 allele).

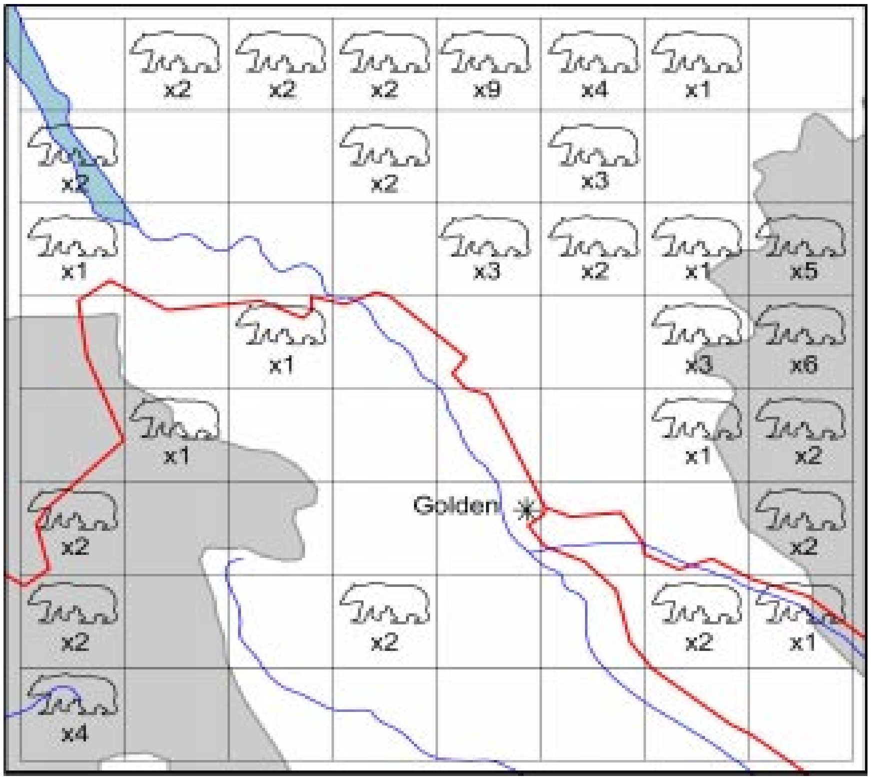

Figure 3. Distribution of 54 grizzly bear genotypes as determined from nDNA obtained from free-ranging bears attracted to barbed-wire hair traps 1996 (see Woods et al. 1999). Each cell represents a 8x8 km grid (64x64 km overall) roughly centered on Golden (*) , British Columbia. The shaded area on the left is Glacier National Park. The shaded area on the right is Yoho National Park. The numbers with each bear symbol indicate the number of genotypes (individual grizzly bears). Bears moving between cells are counted more than once.

In 1996, we identified 54 unique grizzly bear genotypes (25 females, 29 males) and produced a map showing the relative distribution of grizzly bears and black bears (Woods *et al.* 1999). Black bears were found in 63 of the 64 survey sites and grizzlies at 27 sites (Figure 3). These data allowed us to generate a preliminary estimate of 104 grizzly bears (95% CI 86–133) using the study area (see Woods *et al.* 1999 for the limitations to this estimate).

Recently, Strom *et al.* (1999) used this hair-trap DNA-tag survey method in a precursor study to an environmental assessment of a ski resort proposal in the Central Purcell Mountains of British Columbia (about 50 km south of the West Slopes study area). They identified 33 individual grizzly bears including 18 females, 10 males, and 5 bears of undetermined sex. They also presented an unbounded grizzly bear population estimate of 45 (95% CI 37–68) and identified movements of individual bears between hair-trap sites, the relative distribution of bears across the study area, and candidate related bears. Importantly, their data provided a baseline for future monitoring.

The value of non-invasive genetic surveys has received international attention among researchers concerned with bears. At their 1998 North American meeting, the International Association for Bear Research featured genetic work including non-invasive sampling in a special workshop (Woods 1998). More recently, studies using or planning to use this technique have been reported for Panda bears (*Ailuropoda melanoceuca*) in China (Durnin 1999), Asiatic black bears (*Ursus thibetanus*) in Japan (Goto and Huygens 1999), and European brown bears in Italy (Posillico and Lorenzini 2000).

DNA tags offer an alternative to traditional methods such as radio-telemetry and ear-tagging, but we view this technique as an additional tool in gathering field data rather than as a replacement. Depending on the study animal, the situation and the research questions, DNA

Molecular Ecology and Field Biology

- continued from page 8 -

tags may not be a useful. For example, it seems unlikely that home range maps based on DNA would ever be as refined as those based on telemetry. Nevertheless, we anticipate that partnerships between molecular ecologists and field biologists will increasingly provide useful information to help answer the difficult population status questions required for environmental assessments.

We are currently analyzing the 1997 and 1998 genetic tag data and developing more a more refined population estimate. In addition, using genetic material primarily derived from our non-invasive sampling, we are looking at the dispersal of individual bears and the potential barriers to bear movement between sub-populations within the study area.

ACKNOWLEDGEMENTS

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Linking Human Use and Wildlife Movement

George Mercer, Jurgen Deagle and Geoff Carrow

The Athabasca Valley of Jasper National Park (JNP) has been impacted by incremental development and expanding human use. In the Three Valley Confluence area (TVC: situated at the confluence of the Miette, Maligne and Athabasca Rivers), encroaching development is a particular concern because the area includes some of the park's highest quality habitat (Holland and Coen 1993). Researchers are in the second year of a 3-year wildlife movement study to assess wildlife movement in the TVC. The primary objectives of the study are: identify important areas for wildlife movement, evaluate wildlife movement in relation to human use, and determine whether high levels of human use are reducing or eliminating movement opportunities for wildlife. This information will be used to develop strategies to manage human use with greater consideration of the needs of wildlife.

METHODS

The TVC wildlife movement study is designed to monitor grizzly bear habitat effectiveness, security and linkage zones; wolf habitat effectiveness and movement; and wildlife movement in general. The study consists of two components, a broad-scale monitoring component and a specific wolf tracking component.

The first, and largest component is a remote camera/counter project used in conjunction with cumulative effects assessment models to evaluate wildlife movement and human use during the snow-free period (April to October). The remote camera project uses infrared-activated, remote cameras and counters to quantify wildlife and human use (Mercer *et al*. 2000). Spatial cumulative effects assessment models for grizzlies (Gibeau *et al*. 1996) and wolves (Paquet *et al* 1996) were run using ecological land classification and human use data. These models were developed for Banff National Park, but were applied to Jasper for preliminary assessment of cumulative effects. During 1999, random, 2-week samples were collected using remote cameras and counters at 108 sites along human trails and adjacent wildlife trails throughout the TVC. Human trails were rated as low, medium or high use (less than 100, 100-1000 and 1000+ people/month respectively), and wildlife trails were within 3 distance categories (0-199 m, 200-399 m and 400+ m) from the human trails. Distance categories reflect the buffer distances of 200 m and 400 m for non-motorized trails incorporated into the wolf and grizzly bear models, respectively. Data includes the number of events, time, date and species detected. For human use trails, information was collected on type of use. Hiding cover and several other vegetation and physical attributes were measured at each site.

The second component of this study involves an intensive wolf-trapping program (late June to early August 1999) and snow-tracking wolves with hand-held GPS during the winter (November to March). The wolf data will help us determine seasonal and species-specific differences in distribution and movement.

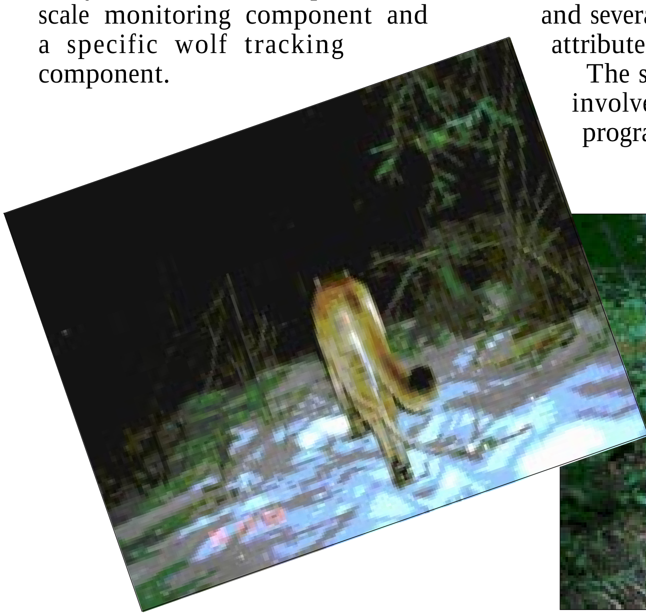
RESULTS

Initial evaluations conducted with the grizzly models suggested grizzly habitat effectiveness and security were below threshold levels in the TVC (Purves and Doering 1998). A preliminary assessment of wolf habitat effectiveness also demonstrated habitat impairment (Walton 2000). Both assessments reinforced the notion that much of the high quality, valley-bottom habitat in the TVC is alienated from use by large carnivores. Within the TVC, the effective habitat for grizzlies was 52%, well below the threshold value of 70% considered necessary to maintain bears in an area. Grizzly linkage zone mapping and wolf movement mapping indicated that higher elevation benchlands provide habitat connectivity for these species.

Wildlife Trails

We detected 60 carnivores (Table 1) at 29% of the sites. Most animals were detected on benchlands surrounding the study area, although some were sighted in riparian areas along the Miette and Maligne Rivers. All wolf, grizzly bear and cougar detections were in areas of low human use on benchlands above 1100 m.

- continued on page 15 -



Infrared photos taken of wildife using trails in the TVC study area.

CONFRONTING CUMULATIVE EFFECTS

Shawn Cardiff

Jasper National Park (JNP) is adapting existing work and creating new tools to focus on an area of special concern in the park. The Three Valley Confluence (TVC*)* area warrants special and immediate attention, given development pressures arising from potential growth of the community of Jasper and outlying accommodation facilities.

The TVC project was initiated in 1997 to (1) identify an array of ecological, social, and infrastructure indicators, which can be used to assess cumulative effects, and (2) conduct empirical research to verify models and enable managers to make informed decisions. These tools will have application at the broader scale of the park and regional landscape. They will be used to support cumulative effects assessment of future projects, and to evaluate opportunities to improve/recover ecological function in the TVC.

TVC describes an area in the heart of JNP, where two tributary valleys, the Miette, and Maligne rivers, converge with the broad Athabasca River valley. Configuration of these low elevation valleys creates a significant axis of wildlife movement and dispersal. Despite its high value for movement, and seasonal concentration of ungulates (Beswick and Leeson, 1987), use of the TVC by wary species is increasingly rare.

The TVC contains the highest potential habitat ratings in the park for species including wolves, grizzly bear, and ungulates. Low-elevation montane areas like the TVC area occupy less than 7% of the land base of JNP. However, most of the estimated 1.6 million annual visitors to JNP will spend time in the TVC. The community has 4,800 permanent residents. With seasonal workers and campgrounds, the TVC accommodates an estimated 20,000 people on summer nights. The TVC is heavily fragmented by large development nodes, highway and rail corridors, and well-used recreation trails.

Environmental assessment activity in the park since 1985 shows over 80% of projects occur within the TVC. Decisions to allow projects to proceed are granted only when they are deemed not to cause significant adverse environmental effects. However, making good decisions on single projects does not guarantee that overall land use goals will be met. This potential "tyranny of small decisions" has potential to continually erode the ecological integrity of the TVC area, in the absence of effective cumulative effects assessment and management.

An initial array of ten indicators was identified for evaluation for the cumulative effects assessment. These were selected by JNP ecosystem specialists, in consultation with external experts. Selection was based upon contributors' knowledge of indicators and stressors, and availability of supporting data, in order to yield early useful results. Of the indicators selected, the initial focus was on carnivores, wildlife movement corridors, and infrastructure.

CARNIVORES

Grizzly bear and wolf cumulative effects models designed by others (Weaver *et al*. 1986, Mattson, 1993, Gibeau, 1998, Paquet *et al.* 1996) have been adapted for the TVC and the park land base (Purves and Doering, 1998, 1999). The Geographic Information System (GIS) is used to model cumulative effects of human disturbance on grizzly bear habitat effectiveness, security area and linkage zone, as well as wolf habitat effectiveness and movement (for details see Mercer on the previous page).

The models accommodate "what if" scenarios, enabling investigation of land use management alternatives. Such scenarios performed on the GIS include boosting human use of a trail or feature to a higher level, removal of selected trails, moving the warden office into town from an out of town location (this has since been done), etc. The models will be validated with empirical data from two comprehensive studies in the TVC area: the Wildlife Movement study, and the Foothills Model Forest Grizzly Bear Research Program.

The grizzly bear cumulative effects model outputs suggest serious concern for the current condition of the TVC. At 61% habitat effectiveness, the TVC is currently below the desired threshold of 80%. Opportunities to improve habitat effectiveness in the TVC are limited, given the area contains large permanent developments like the townsite, outlying accommodations, highway and railway.

Security of habitat is also an issue, and a core security area analysis was conducted. This tool recognizes the importance to grizzly bear survival of minimizing contact with humans. Core security areas are landscape units of nine square kilometers or larger that were without major human activities, a size thought important to meet the daily foraging needs for adult female grizzly bears (Mattson, 1993). Researchers suggest for long term persistence of grizzly bears, 68% of the suitable habitat in an area should be secure. The TVC is currently below threshold, at 53% secure. The linkage zone model output shows the TVC has a high degree of fragmentation, and danger rating, based on intensive human development and high use corridors.

Limitations exist in applying these models at the scale of the TVC (within an individual BMU, or bear management unit); examination of "what if" scenarios requires caution. The models work well to indicate overall condition of a landscape within and among BMUs; however, the models were not sensitive to small-scale development scenarios within a BMU (e.g. additional build up within a developed leasehold).

BREEDING BIRD HABITAT EFFECTIVENESS AND ECOSITE REPRESENTATION

Two new indicators and methods are being developed as a MSc project (Dobson, 2000). The Breeding Bird Habitat Effectiveness Model uses breeding bird inventory data to model the effect of habitat loss and displacement on the ability of habitat to support breeding birds, after factoring in the negative influences of human use and disturbance. It is anticipated this model will enable finer resolution land use assessment than the grizzly bear model.

The ecosite representation model tracks the abundance of ecosite types (determined through the ecological land classification) over time in relation to land use. Several montane ecosites are rare in abundance and limited in areal extent. TVC contains up to 80% of some of these rare ecosite types. If cumulative effects are not

- continued on page 17 -

CUMULATIVE ENVIRONMENTAL EFFECTS MANAGEMENT

TOOLS AND APPROACHES FOR PRACTITIONERS

Cumulative Environmental Effects Management (CEEM 2000)

November 1 to 3, Telus Convention Centre, Calgary, AB

The purpose of CEEM 2000 is to provide clear and practical solutions to assist managers and practitioners to manage cumulative environmental effects pro-actively and effectively. This forum will examine cumulative effects management processes in detail, using examples from a variety of development projects.

Parks Canada and the Cumulative Effects Assessment Agency are participating with the Alberta Society of Professional Biologists (ASPB), Alberta Institute of Agrologists, Association of Professional Biologists BC, and a number of government and industry sponsors to present this international symposium. The format includes general plenary sessions with experts, concurrent technical and case study sessions, a poster session and social events with guest speakers.

Several of the themes for this conference are:

- *Panel Presentations:* Opportunities and Challenges of Cumulative Effects Management: The Regulator's Perspective, The Proponent's Perspective, The Environmental Advocate's Perspective, The Legal Perspective
- *Technical Papers:* Regulatory Opportunities and Challenges, Effects Management Tools, Effects Assessment Tools, Regional Land Use Planning and Monitoring
- *Management Case Studies:* Multi-Sector Developments in Athabasca Oil Sands Region, Regional Ecosystem Management in the Rocky Mountains, Regional Effects Management in Canada's North, Management of Cumulative Effects in a Boreal Forest Landscape, Effects of Urban and Industrial Activities on Canada's West Coast Offshore Fisheries, Energy Development on Canada's East Coast
- *Poster Session Topics:* Emerging Issues and Challenges, Regulatory Issues, Options and Challenges, Responsibilities of Government versus Proponents, Public Expectations, Tools to Manage Cumulative Effects, Examples of Current and Future Initiatives, Regional Land Use Planning, Cumulative Effects Monitoring, Options for Resource Industries

All papers and poster papers will be reproduced in a symposium proceedings.

For details on this conference contact Gavin More, Registrar, CEEM 2000 , Suite 174, #234 - 5419 Country Hills Blvd. NW Calgary, AB, T3A 5K8, 49north@home.com

www.aspb.ab.ca/ceem2000.html

RESEARCH

BEYOND BORDERS: JASPER NATIONAL PARK AND THE CHEVIOT MINE

Parks Canada is participating in the review of the proposed Cheviot Mine near Jasper National Park, currently before a federal-provincial joint Panel. New information in 1999-2000 increased concern for the severity of cumulative effects of the mine, in combination with other land uses. At the same time, advancement of co-operative regional initiatives has created opportunities to improve management of regional cumulative effects. The Cheviot review has galvanised public interest, and has been the subject of a landmark court challenge respecting adequacy of cumulative effects assessment under CEAA. The Panel is expected to release its findings in Summer, 2000.

Parks Canada's objective is to maintain regional landscape conditions to support healthy, viable, connected grizzly bear populations. Achieving that objective is paramount to sustain ecological integrity. Parks Canada concluded at the first Panel hearing (1997), that measures proposed to mitigate effects on grizzly bears were inadequate. The effects of the proposed Cheviot Mine, coupled with other mining, petroleum, recreation and forestry planned for the next 25 years, are cumulatively significant. In its 1999 Panel submission, Parks Canada found the risk to regional grizzly bear populations, including those frequenting Jasper National Park, remains uncertain. Management of many effects are beyond the control of the mine company. A representative observed "Regional problems require regional solutions."

Parks Canada's 5-year intervention in the mine review process is consistent with recommendations of the Ecological Integrity Panel, to improve co-operative working arrangements with provincial and industrial neighbours. Whether or not the mine proceeds, the work ahead will test Parks Canada's ability to influence regional land use planning in a meaningful way.

Adapted from an abstract for Shawn Cardiff's presentation at SAMPA IV, May 1999.

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WILDLIFE MORTALITIES ON RAILWAYS: MONITORING METHODS AND MITIGATION STRATEGIES

Several factors impede the collection of reliable data on railway-killed wildlife including the relative inaccessibility of railway-lines; the lack of experienced individuals to observe, identify, and record railway-kills; and the inherent difficulty of identifying and investigating railway-wildlife incidents from moving locomotives. Data sets on wildlife mortalities along railways may not have sufficient resolution to define issues and suggest mitigation strategies. A recent study near Glacier, Mount Revesltoke and Yoho national parks shed some light on these issues.

HIGHLIGHTS

The CPR parallels the Trans-Canada Highway (TCH) along the Mountain Subdivision of the Canadian Pacific Railway (CPR), crossing the Rocky and Columbia mountains in eastern British Columbia. In this area, the CPR either traverses or runs adjacent to a combination of protected landscapes (Glacier, Mount Revelstoke, and Yoho national parks) and multiple-use (provincial) lands. During 1993-98, we gathered concurrent data on railway-killed wildlife from a single experienced observer and a routine monthly reporting system (several observers). While the two methods identified similar species composition, the experienced observer reports had better resolution to species and identified about twice as many individual railway-kills. Using data from the experienced observer, we illustrated the non-uniform, species-specific, seasonal and geographic distribution of the railway-kills and the potential correlation of scavenger kills to ungulate kills. The result was a list of wildlife attracted to railway-kills and grain-spills. Based on the findings of this research, we have provided 7 recommendations for consideration by jurisdictions and companies addressing railway-wildlife interactions: 1) concentrate mitigation strategies on identified problem areas; 2) develop an on-going training program for running crews to compliment wildlife reporting systems; 3) remove railway-kill carcasses from the vicinity of the right-of-way to reduce attraction to scavengers; 4) remove any spilled attractants (e.g. grain) in a timely manner; 5) reduce chronic grain spillage through car maintenance and handling procedures; 6) manage right-of-way vegetation to reduce attractiveness to wildlife; and, 7) share databases between jurisdictions.

Adapted from an abstract for:

Wells, P., J. G. Woods, G. Bridgewater and H. Morrsion. 1999. Wildlife mortalities on railways: monitoring, methods and mitigation strategies. Page 85-88. In Evink, G.L., P. Garrett and D. Zeigler (Eds). Proceedings of the Third International Conference on Wildlife Ecology and Transportation. FL-ER-73-99, Florida Department of Transportation, Florida. The entire paper can be viewed on-line at: http://www/doc.state.fl.us/emo/sched/ICOWET_III.htm

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EASTERN SLOPES GRIZZLY BEAR RESEARCH PROJECT

Alberta's Eastern Slopes are among the most developed areas in North America where grizzly bears still survive. The Eastern Slopes Grizzly Bear Project (ESGBP) began in 1994 to research the cumulative effects of regional human land use on this sensitive species. Based out of the University of Calgary, the ESGBP is a collaboration of many agencies and stakeholders including Parks Canada, Alberta Environmental Protection, the oil and gas, forest products, development and tourism industries, and conservation groups. During the initial 5-years of research, graduate students, professors and associates have subjected their findings to thesis review, defense, and peer-reviewed publication processes.

Since 1994, 56 grizzly bears were captured, radio-tagged and followed to study the relationship between human activities and bear habitat use and to record births, deaths, and movements. The analysis of over 7000 telemetry locations indicates that grizzly bears in Central Rockies Ecosystem (CRE) have low population densities of approximately 1 bear/50-100 km2. Individual homeranges are large, with males averaging 1172 km2 and females 277 km2. The females' average age of first reproduction is 6.8 years, with an average litter size of 1.9 cubs, and approximately 4-year intervals between litters. These statistics reflect relatively low productivity of grizzly bears in the CRE.

In the approximately 42,000 km^2 study area, there were 639 known grizzly bear mortalities between 1971 and 1996 — 627 of these were human-caused. The majority (85%) of human-caused mortality occurred within 500 m of a road, or 200 m of a trail. Human use of the region is so intensive that it appears many adult females have inadequate area secure from human disturbance. We are working to identify essential grizzly bear habitat and its relationship to human use throughout the region.

Positive changes in grizzly bear management include a human-caused mortality target of not more than 1% of the population per year (Banff, Kootenay,Yoho, Jasper and Waterton Lakes national parks. All 5 mountain parks have established habitat effectiveness and security targets on a Carnivore Management Unit basis. Major new developments in Kananaskis Country were rejected, partly in response to the grizzly bear population and habitat analysis provided by the ESGBP. In other crown lands of Alberta and BC that make up 60% of the CRE study area, land managers and resource developers work to manage cumulative effects of development on grizzly bears.

Within the next 2 years we will have a computer-based map of grizzly bear habitat quality, quantity, and human use for the broader study area. Cumulative effects models should be interfaced with improved socio-economic information to plan a landscape suitable for grizzly bears and people.

For more information about
the ESGBP visit our website at
http:// www.canadianrockies.net/grizzly

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Square hooks for exotic brooks

- continued from page 7 -

fish from lakes. For example, for lakes with habitable inlets and outlets (Bighorn Lake has neither), removal of non-native fish from inflowing waters and installing barriers to prevent their reinvasion from outflow creeks will be required. It may also be desirable to selectively remove introduced fish from lakes that have one or more populations of native fish. Gillnets capture and kill native and non-native fish without distinction. Further, non-target species such as Harlequin Ducks *(Histrionicus histrionicus)*, and even grizzly bears *(Ursus arctos)* might be adversely affected by restoration activities. Diving birds may drown in gillnets, and bears may lose a food resource if spawning runs of fish are eliminated.

Approximately 25% of the naturally fishless lakes of the mountain national parks were stocked with sportfish earlier this century. The removal of established, non-native fish stocks with gillnets alone is feasible, but the technique may be best suited to ponds and smaller lakes that lack habitable inflow or outflow creeks, and that generally do not harbour native populations of fish or other threatened wildlife. Our successful reintroduction of extirpated species suggests complete invertebrate community recovery is possible even decades after lakes were damaged. However, the objectives and potential difficulties associated with specific fish removal projects must be carefully considered. If large, expensive and publicly visible restorations fail, it may become difficult for researchers to gain support for aquatic restoration work.

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Linking Human Use and Wildlife Movement

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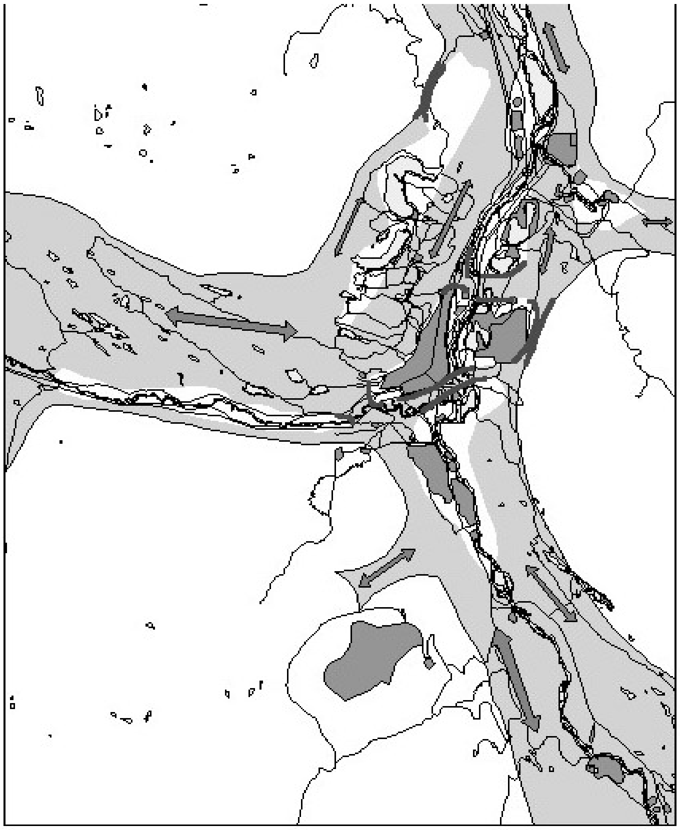

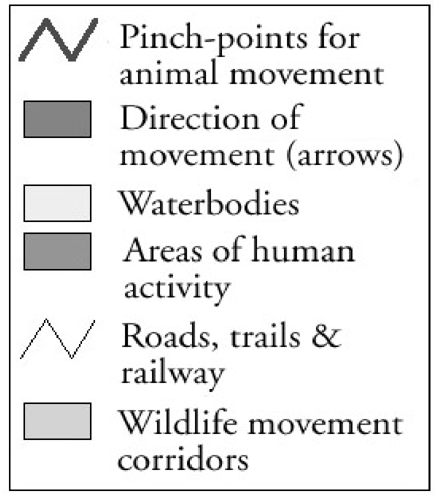

Conceptual Wildlife Movement Corridors in the Three Valley Confluence area.

Table 1: Number of detections by species.

Species	No. Detections
Black Bear	37
Coyote	11
Wolf	5
Grizzly Bear	4
Cougar	2
Fox	1
Lynx	0*

** Lynx were the only resident large carnivore species not detected in the 1999 study.*

Wildlife comprised 90% of the activity on wildlife trails. Humans accounted for the remaining 10%. (Of these users, 47% were hikers, 47% were mountain bikers and 6% were horse users.) The number of carnivore detections decreased by 42% from low to high human use areas. There was also a significant interaction effect between level of human use and detection distance, suggesting that as human use increases carnivores are displaced greater distances. Carnivores were not detected in the valley bottom where we recorded the highest levels of human use. Wildlife detections occurred throughout the day including mid-afternoon (1300-1500) when human use peaked.

Human Trails

Wildlife comprised 26% of the activity on human trails, and consisted of both carnivores (11%) and ungulates (89%). Of the carnivores, wolves were observed only on low use human trails. Black bears and coyotes were also observed on medium and high use human trails. In total, wildlife comprised only 5% of the activity on these trails.

Use on human trails ranged from 0 to 3,000 people per two-week sample. Use was low in early May, but rose quickly in June and peaked in July. During the summer months, as many as 250 people/month used low use trails, sugesting that many of these trails need to be reclassified. Users of these trails included mountain bikers (67%), hikers (27%) and horse users (6%). On medium and high use trails, hikers accounted for 67% of use followed by mountain bikers (30%) and horse users (3%). All wildlife detections on medium and high human use trails occurred from 0700-1200 and 2100-2200. Human use on medium and high use trails peaked from 1300-1500 with no users detected from 2300-1000.

DISCUSSION

Human use can shift wildlife both spatially and temporally, potentially preventing some species from using the area. Spatial models predict that large carnivores are essentially alienated from a large portion of the TVC. Field data from 1999 support the model prediction as much greater numbers of carnivores were detected in areas removed from high levels of human use, particularly in riparian areas. Data clearly show a relationship between increasing human use and decreasing carnivore detections, and this trend points to the overall effect of increasing human use in the TVC.

Although our analysis is unable to establish a threshold value beyond which carnivore movement might be eliminated from an area, no cougars, wolves of grizzly bears were detected in areas with over 1000 human users per month. It is possible that wildlife movement could be eliminated in

- continued on page 16 -

Linking Human Use and Wildlife Movement

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areas with lower levels of human use if terrain features or anthropogenic barriers restricted movement. In areas where numerous wildlife trails exist, wildlife may be able to tolerate higher levels of human use. These areas probably meet the criteria established for wildlife movement corridors (Beier and Noss 1998; Beier and Loe 1992) and the network of trails provide wildlife with options for avoiding human use. Fewer opportunities for movement may effectively sever population connectivity. Some species of wildlife may be able to deal effectively with existing levels of human use by using areas further away from human activity or moving through higher use areas in the early morning or late evening.

Another important result of the 1999 program was identifying species-specific differences. From late June to early August an intensive wolf-trapping program did not capture any wolves, and revealed little evidence of wolves within the study area. These results corroborate anecdotal information suggesting that wolves vacate the study area in summer, returning for the winter by October or early November. All wolf detections occurred on bench lands above 1100 m, in areas of low human use. Black bears and coyotes were the only large carnivore detected in the valley bottom at elevations below 1100 m. Ungulates frequented the lower portions of the valley bottom where human use is generally higher. These species may be seeking refuge from carnivores and/or are less wary of humans

Our results suggest that wary large carnivores including wolves, cougar and grizzly bears are alienated from the high quality, valley bottom habitat of the Three Valley Confluence by high levels of human use. Large carnivores are shifted to movement areas on the periphery of the TVC, where human use is lowest. Expanding use of unofficial trails in these areas has the potential to further displace these species and effectively cut off some movement corridors.

Careful management of human use will be essential to ensure wildlife movement areas are maintained. Management actions could include: educating trail users regarding wildlife movement concerns, assessing and managing the types of use, enforcing permanent or seasonal closures of important movement areas, developing a human use management strategy for the TVC, and monitoring the effectiveness of management actions. The role of communications in raising the level of awareness, appreciation and understanding for the needs of wildlife cannot be overstated. Communications is recognized as a critical element of any initiative to mitigate the impacts of human use on wildlife movement through the TVC.

Monitoring in 2000 is focusing on areas deemed important for wildlife movement and will continue to refine our understanding of how wildlife move in relation to human use in the TVC. This information will be critical to assist park managers in making land use and human use management decisions for the Three Valley Confluence that complement the park's objectives for maintaining functioning wildlife movement areas.

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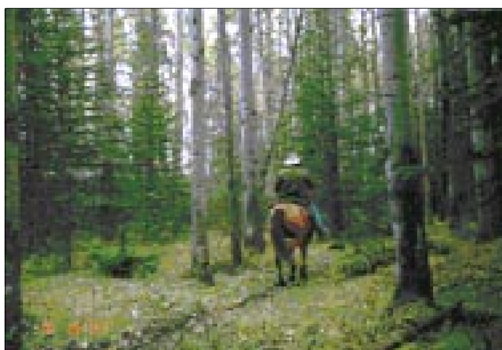

Infrared photos taken of human activity on trails in the TVC study area.

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CONFRONTING CUMULATIVE EFFECTS

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adequately considered, land use in TVC could result in the loss of the majority of the representation of an ecosite type for the park. Tracking the cumulative impacts in rare ecosites will help ensure development is not inadvertently planned for rare habitats.

WILDLIFE MOVEMENT CORRIDORS

Wildlife movement corridors are essential to maintain habitat connectivity. A conceptual map of wildlife movement corridors was produced, based on biophysical land classification, limited wildlife tracking studies, and the expert advise of knowledgeable park staff. The map indicates perceived important travel routes, and pinch points, where corridors are constricted by topography, built infrastructure or other human use.

Field investigation is underway to generate real data respecting wildlife movement and use of the corridors, and to establish a long term monitoring program. Future design analysis may be conducted, using detailed criteria of length, shape, width, cover, etc. established in scientific literature.

INFRASTRUCTURE: *POWER DEMAND*

Data are available to extrapolate condition under build-out scenarios; however actual build-out conditions are uncertain due to policy status of community plan and Outlying Commercial Accommodation Guidelines. Power, for one, imposes a readily foreseeable threshold, as the local generating station has fixed capacity. Unmanaged demand will trigger the need for high environmental impact twinning of the natural gas pipeline into the park, or likewise damaging construction of overhead power lines to connect to the provincial grid. Allocation needs to be addressed at the planning level, with meaningful conservation initiatives identified through individual development submissions.

CONCLUSIONS

Carnivore cumulative effects models are at present the main strengths in the framework. These were developed elsewhere and adapted for the park. The utility of the breeding bird diversity and ecosite representation models are being evaluated. Virtually no progress has been made on social indicators, vegetation condition, and special features, and this is of concern.

It is imperative that indicator development be accompanied by research/monitoring for baseline comparison, and to validate models. A TVC wildlife movement study is underway, and Parks Canada is contributing to a major regional grizzly bear research program, administered through the Foothills Model Forest. That program is expected to produce data to verify the grizzly bear cumulative effects models, and refine underlying assumptions for local conditions.

The cumulative effects framework is intended to evolve as new methods become available, and indicators are added or eliminated. A focus will be to obtain indicators and analysis that operate at different scales of resolution, and involve more taxa, including insects, amphibians, songbirds, and other carnivores.

The project is not represented at this time as a cumulative effects assessment of the TVC. However, some indicators, specifically the grizzly bear models, are developed to the point where conclusions can be made with respect to cumulative effects. For example, current habitat effectiveness and security area values in TVC are well below thresholds to sustain grizzly bear use. From the viewpoint of the grizzly bear models, opportunities to improve conditions are severely limited, under the assumption that the "big ticket items" will persist: community infrastructure, highway, railroad and outlying accommodation. Cumulative effects results for ecosite representation and breeding bird habitat show that the greatest levels of development and cumulative effects are occurring in some of the rarest, and most breeding bird rich ecosites in the park. The model results impart urgency to manage existing cumulative effects and very seriously evaluate implications of new actions. It is time to seriously contemplate recovery actions to prevent further deterioration of ecological integrity in the Three Valley Confluence.

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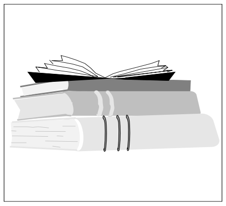
BOOK REVIEW



"The Heritage Crusade and the Spoils of History"

by David Lowenthal

Cambridge: Cambridge University Press, 1998. 338 pp. ISBN 0521 635264 (paperback)

Review by Graham MacDonald

The Heritage Crusade represents a masterful summary of themes which have long preoccupied English geographer, David Lowenthal. His main purpose is to distinguish the large differences in meaning which attend popular use of the terms "heritage" and "history." The author sets out to do this on many fronts, including an inspection of how these ideas influence our daily lives. On the surface, the words appear to have fairly self-evident meanings. His main argument is that "history," as an important idea in public discourse, is fundamentally different from the idea of "heritage" with which it is often linked. Indeed, many people tend to almost equate the two concepts.

In Lowenthal's view, equating history and heritage is a categorical error, because the two concepts arise from different motives. In Lowenthal's view, equating history and heritage is a categorical error, because the two concepts arise from different motives. Written "history" attempts to establish a verifiable version of events whereas "heritage" is clearly linked to what many individuals or groups perceive as their "inheritance." Lowenthal uses a wide range of examples to distinguish between the two terms as he discusses their individual and collective uses in the past, politics, religion, parks, museums, historic sites, tourism, genealogy and science. In what is perhaps his most original chapter — *Being Innate*— Lowenthal examines the implications of modern genetics research for emerging popular ideas about personal identity. Through this and other timely examples, he somewhat relentlessly drives home his thesis that historical understanding and heritage appreciation emanate from different motives.

What is the nature of these motives? To put it simply, historians tend to inspect the past for its own sake, while heritage advocates tend to appropriate versions of the past for various kinds of propaganda, which is to say, to further some contemporary agenda. This distinction is familiar to historians, who often speak of the notion of "presentism" in the same context (111-12). Lowenthal prefers the term "updating" (148). In this book he has very successfully taken this idea out of the scholarly journals and raised it up for inspection by the general reading public through a rich variety of case studies.

The notion that history and heritage are similar in character is explainable because both historical knowledge and heritage awareness concern the past. A historian's scrutiny of the past arises from a historical question, such as: why did World War I take place? On the other hand, a person concerned with the "heritage" implied by that same event may seek to re-enforce an already established image of that event in the support of a contemporary cause or group. "Like medieval relics, heritage is sanctioned not by proof of origins but by present exploits" (127). Heritage often tends to be "created to generate and protect group interests" (128). Lowenthal states that heritage "is not a testable or even a reasonably plausible account of some past, but a *declaration of faith* in that past" (125). This faith may be distinguished from a more genuine historical understanding, achieved within such limits of objectivity as are possible. History is tentative, subject to revision, based on new or shifting views of the evidence (120). The polarization between the two ideas may be put starkly: "If historians despise heritage fakery, heritage disdains historian's truth fetishes" (127).

The question of bias and fairness of judgement is of special concern to people in organizations with an educational mandate. In Lowenthal's analysis there are several contemporary strains of heritage thinking which often come into conflict with the historian's desire to establish balanced accounts of national or group achievements. Conflicts can arise from ulterior motives when requesting recognition of group identity, identifying the virtues or importance of a personality, repatriating cultural objects, commemorating a social movement, a building, a language, a singular development in science or culture or an event. Lowenthal senses that there is often a fine line between the claims of history and the claims of heritage (111). It is presumably the task of the public historian to try and make that distinction clear.

One of the great virtues of *The Heritage Crusade* is that the author has done his best to view the conflict between heritage and history from an international perspective. He says peoples associated with the European tradition appear to have a strong materialist bias in their outlook on history and heritage. Museums and archives abound, and from a financial point of view, many such repositories are now stretched well beyond their limits owing to "heritage glut." Archaeological collections also suffer from success: "more and more of what has been excavated languishes unseen and awaiting analysis" (11-12). Similarly, he states the preoccupation of many with "built heritage" has taken on "crusade" overtones, enshrined in the UNESCO sponsored Venice Charter of 1966 which emphasized "original materials." This European-inspired charter has led to the rise of "cultural resource management" as a prime policy objective in many European and American land management agencies. Lowenthal contrasts this material bias with many non-European cultures that "place more emphasis on spiritual values, on authenticity of thought, than on material symbols"(20).

Lowenthal does well to distinguish between the material and the spiritual, as it is important for those in land-based agencies with mandates to consider cultural resources. He details a full range of situations in which those who have been colonized, are now seeking redress, not just from legal forms of past restraint but also for what they perceive to be lost "heritage."

- continued on page 22 -

Have We Crossed the Threshold?

Site Development and Cumulative Impacts on National Historic Sites

David Hems and Paul Downie

Cumulative effects are the accumulation of incremental impacts that collectively "nibble" (Kingsley 1997) away at the commemorative integrity of a site, including not only resources identified as "nationally significant" but those which reflect the general range of human history at a particular site. The theory of cumulative impact assessment has existed for many years but has been a difficult process to implement. Difficulties include the fact that many impacts are long-term processes, include a range of variables, and often fall within multiple jurisdictions. Parks Canada's national historic sites are excellent subjects for cumulative impact assessments because incremental impacts can be closely monitored on property within a defined boundary and under one jurisdiction. Close examination of cumulative impacts to national historic sites should enable Parks Canada to set thresholds for preserving commemorative integrity. These thresholds can result in better guidelines for Commemorative Integrity Statements (CISs), and make it easier to address cumulative effects through management plan reviews and environmental assessment.

Commemorative integrity is achieved when "the resources that symbolize or represent its importance are not impaired or under threat, when the reasons for its significance are effectively communicated to the public, and when the heritage value of place is respected" (Parks Canada 1994).

"NIBBLING" AT SITE INTEGRITY

Site development at many historic sites over the years has resulted in an accumulation of impacts with each impact assessed individually. Cultural resource impact screening has traditionally looked at each project proposal in isolation, and has not considered the cumulative effects of impacts from previous and proposed projects. Typical projects at historic sites are the construction of visitor facilities and administration buildings, installation of utility lines, development of trails, landscaping, building restoration and reconstruction. Each land disturbance has the potential to alter or obliterate the context and relationships of sub-surface cultural remains and environmental information associated with those remains. Each intervention to a historic building may gradually remove structural elements that form the basis of its historic value. The following is an example of a cumulative impact approach at St. Andrew's Rectory National Historic Site.

A CASE STUDY IN CUMULATIVE IMPACT ASSESSMENT

St. Andrew's Rectory is located north of Winnipeg on the west bank of the Red River in the vicinity of St. Andrew's Rapids. In 1854, construction of the rectory was completed by the Church Missionary Society which supported the mission at St. Andrew's from 1829 to 1887 (Guinn 1978). The property was sold by the parish in 1943, changing hands again in 1948 and 1965. It was first used as a family residence and later as a museum (Guinn 1978). The Government of Canada purchased the rectory in 1976 following the Historic Sites and Monuments Board of Canada recommendation that the rectory be acquired for preservation as a national historic site (Guinn 1978). Parks Canada restored the rectory to its original appearance, the grounds were landscaped, and facilities to serve the needs of the site were installed.

METHODS

Archaeological and historical reports, notes, and memos formed the basis for much of the information gathered on the site's cultural resources. These documents recorded the activities and findings associated with major restoration and landscaping, as well as smaller projects such as the installation of the interpretive node and utility lines. Valuable supplementary information was obtained from plans, notes, photo records, and terms of reference held by Real Property Services (Public Works Canada) and the Restoration Workshop (Western Canada Service Centre). Two basic tools for tracking the site's cultural resources and impacts were created from this information: a cultural resource management database, and a site map.

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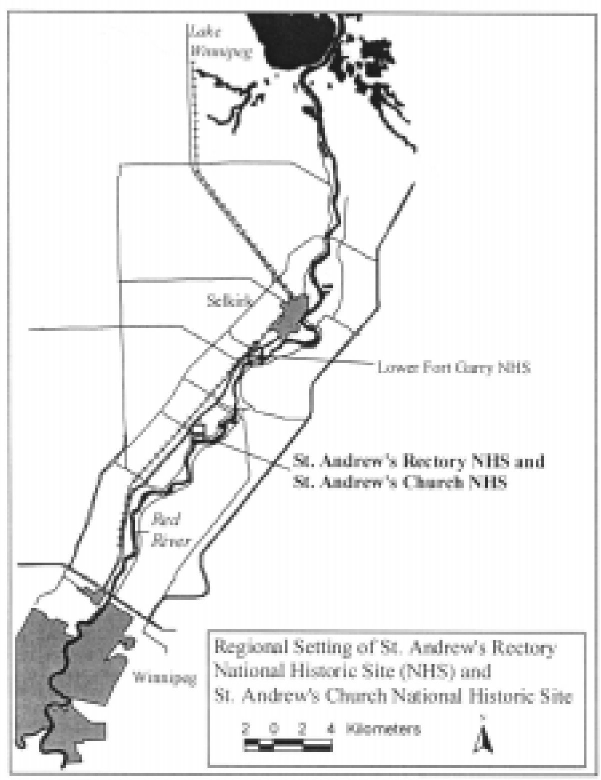

Have We Crossed the Threshold?

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RESULTS

Three standing structures, twenty-nine cultural features and the unverified locations of nine structures associated with the pre-1943 occupation have been inventoried. Another forty-four features and installations associated with subsequent occupations, including that of Parks Canada, have also been recorded. Twenty-two investigations between 1975 and 1997 documented changes to the site and its resources.

Impacts to cultural resources can be traced back to the construction of the rectory in 1854. Archaeological investigations revealed that the rectory was built upon the remains of an earlier structure marked by a shallow stone footing and a large deposit of ash and baked limestone. Modifications to the original annex and lean-to were made prior to 1890 and all remains of the original annex were removed after 1938. During the period from 1940 to 1975 the original chimneys and verandah were removed, the cellar was enlarged, and indoor plumbing was installed, including a well and septic tank. There were also numerous changes to the interior of the rectory.

The rectory stabilization and development of interpretive facilities in the early 1980s removed fill associated with the pre-rectory structure and the original annex, and disturbed all stratigraphic associations with these structures. A high proportion of new material was incorporated to the structure during renovations and much of the work showed 1980s craftsmanship (Hoskins 1999). Based on Hoskins' intervention review, the Federal Heritage Buildings Review Office determined the work carried out on the rectory essentially made the structure a reconstruction (Moreau 1999).

Other impacts to the site's cultural resources resulted from landscaping activities including planting, the development of visitor facilities, the construction of drainage channels, foot paths, driveways, and utility installations. Most of these projects occurred behind the rectory and affected approximately 50% of the land where there is the greatest likelihood of encountering outbuildings associated with the rectory and the early period of the mission. Approximately one quarter of the area northwest of the rectory has been disturbed by the construction of drainage channels and the installation of a native grass plot. Both of these projects have disturbed the remains of previous structures and other cultural features and artifacts, and adversely affected remains associated with the historic evolution of the site.

Photo: Mary Ann Tisdale

Heavy equipment was used in the expansion of an existing drainage channel at the northwest corner of the property in 1996 causing impacts to an historic fence line and unearthing historic artifacts.

CONCLUSIONS

St. Andrew's Rectory National Historic Site contains a range of cultural resources including some that predate the 1854 construction of the current rectory. Decisions regarding further development of St. Andrew's will have to consider these cultural resources in addition to the commemorative integrity of the rectory structure to establish thresholds for future initiatives. The rectory was commemorated for its architectural significance, and although the FHBRO evaluation determined it was a 1980s reconstruction, original structural elements were incorporated into the structure. These Level 1 elements must be maintained. Furthermore, close to 50% of the rectory property has been disturbed, so future development should be confined to previously disturbed areas or implemented in a manner that preserves subsurface contexts.

A management plan review examines proposals in the context of the commemorative integrity objectives, considering initiatives outlined by the previous plan and eventually establishing a direction for future actions. The review allows managers to assess the new initiatives relative to past and present projects as part of the environmental assessment of the plan. This assessment can help managers determine whether the threshold for site integrity is in danger of being crossed, or, if already crossed, further impaired by future actions. Such decisions must not be made by assessing each proposal in isolation because once the threshold is crossed it is impossible to restore commemorative integrity. However, it is possible to preserve values associated with the remaining cultural resources on site by mitigating further "nibbling" of those values. It is only through a review of past impacts that we can determine what is left to preserve for future generations.

ACKNOWLEDGMENTS

Access to documents relating to past initiatives at the site was made possible with the cooperation of many individuals, in particular Lorne Campbell and Steve Miville of Real Property Services, and Sandy Siepman of the Restoration Workshop. Without the support of Linda Seyers from the Manitoba Field Unit the cumulative impact assessment at St. Andrew's Rectory National Historic Site would not have occurred.

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WHAT IS THE ROLE OF CUMULATIVE EFFECTS ASSESSMENT IN ADAPTIVE MANAGEMENT?

Suzanne Therrien-Richards

The Panel on Ecological Integrity of Canada's National Parks recommends adaptive management "as a means for Parks Canada to best integrate learning into its planning processes, to continually improve management for the protection of ecological integrity" (Parks Canada Agency 2000). Figure 1 represents a modified version of the adaptive management framework proposed by the Panel for Parks Canada. In this framework, the cumulative effects assessment of the management plan can become a key tool in a more holistic and cyclic approach to planning for heritage places managed by Parks Canada.

HOW DOES CEA FIT INTO THE ADAPTIVE MANAGEMENT FRAMEWORK?

All management plans in Parks Canada are subject to environmental assessment as set out in *The 1999 Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals* and under the *Parks Canada Guiding Principles and Operational Policies*. The environmental assessment examines management actions to make sure they conform to the goals and purpose of Parks Canada. In national parks, the management plan will reflect the com-mitment to protecting ecological integrity; actions in the management plan would therefore be examined for their impact on ecological integrity. In national historic sites and canals, upholding commemorative integrity is the goal of management planning; actions in the management plan would therefore be examined for their impact on commemorative integrity. The environmental assessment would consider impacts from individual management actions, but more importantly, the assessment of cumulative effects would consider the effects of new management actions on the integrity of heritage places, combined with all current and past management actions.

In the adaptive management framework, management actions are the experiments that need to be monitored and evaluated. Since the intent of cumulative effects assessment is to monitor and evaluate management actions, past, present and future, the cumulative effects assessment of the management plan becomes a key tool in the adaptive management framework. In doing the cumulative effects assessment, the combined impacts resulting from management actions (the experiments) are evaluated through monitoring for their impact on the ecological and commemorative integrity goals (the predictions). If necessary, management actions can be changed to reduce the impacts, or alternately, goals and policies can be revised based on new scientific knowledge. Any changes would also be evaluated and the cycle of adaptive management would be repeated.

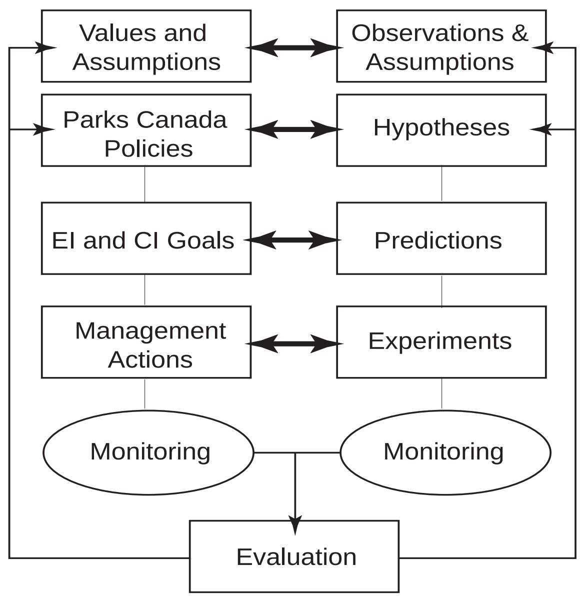

Figure 1. Adaptive Management Framework in Parks Canada

The cumulative effects assessment can also direct research that is needed to fill information gaps in support of the adaptive management philosophy of learning while doing. In this way, Parks Canada can continue to undertake management actions that will be carefully controlled experiments outlined in management plans. This is particularly important for those parks and sites that have not developed ecological or commemorative integrity statements. In the adaptive management model, this means that the predictions are missing and it would not be possible to determine whether or not actions identified in the management plans are resulting in adverse cumulative effects. In the absence of information or with incomplete information, the cumulative effects assessment can be used to provide guidance to park managers as to the monitoring that is needed to set goals, indicators and targets.

TOOLS FOR CEA

In conducting the cumulative effects assessment, the management actions in the management plan and other actions that contribute to impacts (past, existing or planned for the future) need to be identified and their impacts measured in some way. Several tools can be used but spatial analysis using geographic information systems (GIS) is a powerful method of both identifying and quantifying physical properties of actions that is being used more frequently. Examples of actions that are particularly suited to GIS analysis include road development, land clearing, and other activities resulting in changes to landscape features.

Examples follow:

In Prince Albert National Park, Saskatchewan, the cumulative environmental impact of development in the townsite of Waskesiu has been assessed by comparing the change in the landscape over time using an energy classification system. This information can now be used by park managers to set goals on the desired amount of natural landscape in the townsite. Any future management action, whether development or restoration, would then be assessed for impacts to the natural landscape and compared to the goals that had been adopted to determine whether or not the action was appropriate.

A similar process of identifying and mapping surface and sub-surface impacts has been carried out at Riel House (Downie and Priess 1998), Lower Fort Garry (Toews

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WHAT IS THE ROLE OF CUMULATIVE EFFECTS ASSESSMENT...?

- continued from page 21 -

*et al.*1998) and St. Andrew's Rectory (Downie and Priess 1998) national historic sites in Manitoba. The cumulative effects assessment of past management actions provides useful information on previous disturbances to cultural resources and their complexes. Based on this information, a commemorative integrity goal can be set. Any new management actions that may further disturb surface and sub-surface cultural resources could be mapped and the value of disturbed area could be calculated. This value could be compared against the goal to determine whether the proposed management action would be acceptable.

The use of key indicators or valued ecosystem components is another technique for cumulative effects assessment that is particularly useful to assess changes in heritage places at the landscape level. Key components are valued for their ecosystem, scientific, social or commemorative role. As parks and sites complete Ecological Integrity Statements and Commemorative Integrity Statements as part of an approved management plan or in advance of the management planning process, measurable components and targets will be established for the strategic goals. The measurable components and goals will be parameters that are well defined, measurable and verifiable, and that provide information on trends over time.

As an example, an indicator of the maintenance of a population of native species could be the population size of grizzly bears in the park. To maintain a viable population in the greater park ecosystem as an objective, the goal could be defined as a minimum number of 50 breeding females with an annual mortality of less than 2%. The cumulative effects assessment would therefore attempt to quantify the impact of the combined management actions on the grizzly bear population. If the results indicated that the management action adversely impacted on the population, or that the goals had been set too low, adjustments would be made to the management action or the goal could be revised as part of the adaptive management framework. This would be followed up with monitoring to test the new management actions (the experiments) or the predictions (the goals).

CONCLUSIONS

Management plans identify management actions in national parks, national historic sites and canals, and marine conservation areas that may result in cumulative environmental effects. Using assessment tools as described above, the cumulative effects assessment becomes a key tool in adaptive management. It can provide feedback on past management decisions and guide future initiatives. The cumulative effects assessment can also be used to provide guidance to the park managers as to the information that needs to be collected to set ecological and commemorative integrity goals, indicators and targets. Monitoring and evaluation of management actions and their effects on the goals provides a feedback loop to make adjustments to either the management actions or to goals in a continuous learning process of adaptive management.

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BOOK REVIEW:
"The Heritage Crusade and the Spoils of History," by David Lowenthal

- continued from page 18 -

Daily newspaper articles reveal how "heritage struggles" take place globally, including situations ranging from local attempts to repatriate resources, artifacts and lands, to exercising censorship over research into group "patrimony" and ultimately into political separatist movements and civil wars. This is the difficult part, says Lowenthal, where historians and heritage advocates must work together: "Falsified legacies are integral to the exclusive purpose of group identity" (132) and the implication of any claim to a group proprietary interest in "heritage" is that "History is for all. Heritage is for us alone" (128). The "presentist" or "update" impulse at work in such situations is clearly the drive for retrospective group justice. This suggests that any Government organization which seeks to represent national "heritage" or "history" as a fundamental aspect of its mandate, has a very delicate series of assignments before it.

The Heritage Crusade is an important achievement and summation by a scholar who has spent much of his life observing how different peoples make sense of their past. The author's breezy style makes it a pleasure to read and his references are extensive. In addition to historians and curators, it will be invaluable to public land administrators involved in natural and cultural resource management, and to natural and social science interpretation staff.

Graham MacDonald is an Historian, Western Canada Service Centr, Calgary.

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"... explores the roles of public and private agencies and stakeholder representation in the Precontact Cultural Heritage Site Management Process and further identifies issues affecting that management;" for "Waterton Lakes National Park,... and the geographic regions adjacent to it, including Akamina Kishenina Provincial Park,... Flathead Provincial Forest,... Glacier National Park,... Castle-Carbondale River Valleys, Front Range Canyons and Foothills of Alberta..."

WHAT IS "Recently In Print"?

The ecological integrity panel noted Parks Canada's general lack of published articles in peer-reviewed, refereed journals in their observations on Parks research. *Research Links* is introducing a new feature, "Recently in Print" listing titles of formally published research by staff and partners in an around national parks. This material is usually only available in technical journals that are rarely seen outside university libraries.

SUBMISSIONS

To be included in this list, a paper must be published in a peer-reviewed/refereed journal (Masters or PhD level theses are also acceptable), and include work within the boundaries of one or more national parks or historic sites. We will not publish citations for "submitted" or "in press" items in this list.

To submit an item for "Recently In Print," please send re-prints, copies or signed title pages of appropriate items published in 1998 or later to:

Research Links
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Calgary, AB T2G 4X3
Fax: (403) 292-4404
e-mail: Research_Links@pch.gc.ca

MEETINGS OF INTEREST

September 9-13, 2000

The 7th International Symposium on Environmental Concerns in Rights-of-Way Management. Westin Hotel (Downtown), Calgary, AB. The 7th Symposium will address environmental issues in rights-of-way management and provide a forum for information exchange among environmental professionals from a wide variety of agencies, industries and academic organizations. Contact: Dean Mutrie, Steering Committee Co-Chair, TERA Environmental Consultants (Alta.) Ltd. Suite 205, 925 - 7th Avenue SW, Calgary, AB T2P 1A5. Tel: (403) 265-2885; fax: (403) 266-6471; e-mail: dmutrie@teraenv.com or web site: http://www.rights-of-way-env.com

September 22-25, 2000

Annual Conference of the Canadian Amphibian and Reptile Conservation Network (CARCNET). Penticton Trade and Convention Centre, Penticton, BC. This conference is being held in one of the most unique and endangered ecological regions in North America — The South Okanagan of BC — Canada's only "arid" desert. The herpetile fauna of the Okanagan Valley consists of 8 amphibians and 11 reptiles, some of which are found nowhere else in Canada. This conference will feature symposia on volunteer monitoring programs, wetland conservation issues, important reptile and amphibian areas in addition to the regular program of contributed papers and posters related to herpetological research and conservation issues. Contact Larry Halverson: Box 220, Radium Hot Springs, BC, V0A 1M0. Tel: (250) 347-2207; fax: (250) 347-9980; e-mail: larry_halverson@pch.gc.ca

October 17-19, 2000

Managing for Bears in Forested Environments. Revelstoke, BC. Hosted by the Columbia Mountains Institute of Applied Ecology. The conference features3 workshops: 1) techniques to monitor bear numbers, 2) forest management issues and guidelines in bear habitat, and 3) living in bear country. Workshops will feature case studies as well as the latest in research techniques and findings. Field trips will illustrate a variety of bear management issues and solutions (electrification of langdills, DNA census methods, guidelines for access management). Contact: Columbia Mountains Institute for Applied Ecology, Box 2568 Revelstoke, BC. V0E 2B0 (Check PC). Tel: (250) 837-9311; e-mail: cmi@revelstoke.net; web site: www.cmiae.org

November 1-3, 2000

Cumulative Environmental Effects Management: Tools and Approaches. Telus Convention Centre, Calgary, AB. Presented by the Alberta Society of Professional Biologists, in partnership with the Alberta Institute of Agrologists and the Association of Professional Biologists of BC. Specific topics include: implementation of regulatory approvals and environmental management processes, monitoring/adaptive management, legal requirements and public needs. Participants involved in the regulation and assessment of cumulative environmental effects will receive guidance in this challenging discipline. Contact: Gavin More, Registration and Communication. Tel: (403) 239-4248; e-mail: 49north@home.com Conference Mailing address: Suite 174, 234 - 5149 Country Hills Blvd. NW Calgary, AB T3A 5K8 Web site: http://www.aspb.ab.ca/conference.htm

April 24-26, 2001

International Conference on Restoring Nutrients to Salmonid Ecosystems. Eugene, Oregon. Hosted by the Oregon Chapter of the American Fisheries Society and sponsored by other regional AFS chapters and agencies. The purpose of the conference is to showcase the latest information on one of the most pressing issues affecting the recovery of Pacific salmon and their ecosystems. A plenary session will include presentations from key researchers throughout the North Pacific ecoregion. Contributed papers and posters describe case histories, hypotheses and research related to the North Pacific Rim. Registration forms will be available in October 2000. For information contact Richard Grost: Tel: (541) 496-4580; e-mail: rgrost@compuserve.com

***Research Links* is available in PDF format on the Parks Canada main website:**

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under Library in the Download Documents section.

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