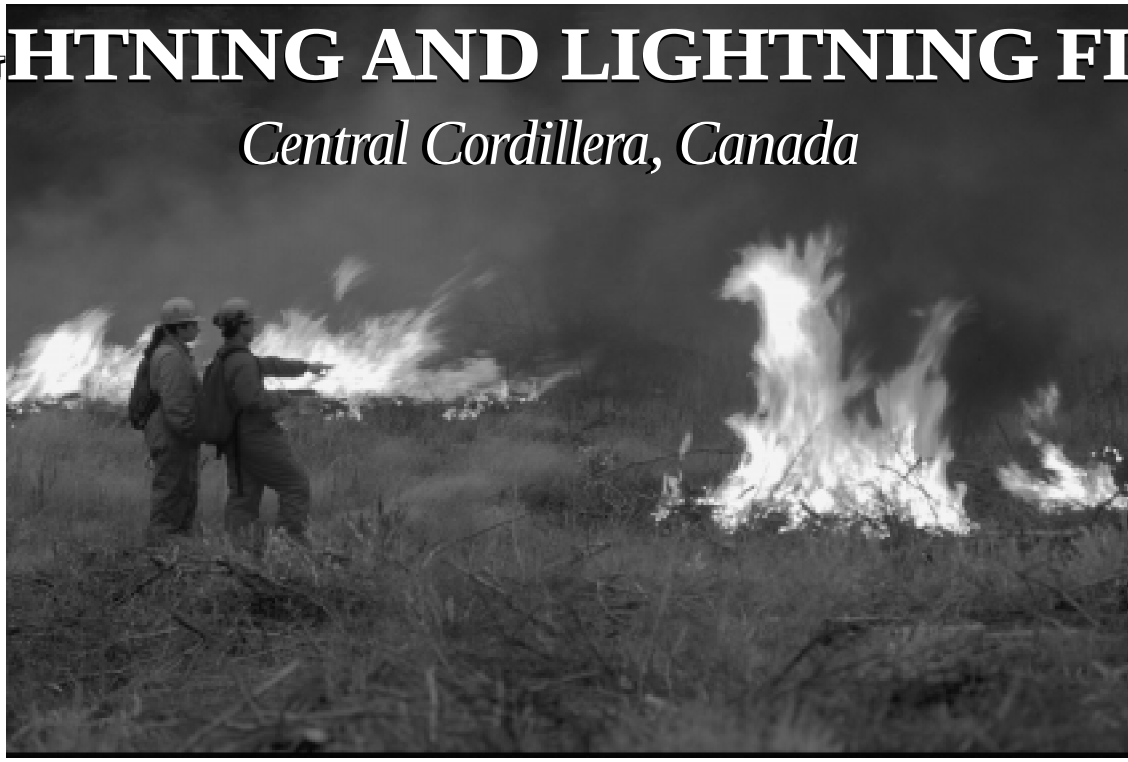
Research Links

A Forum for Natural, Cultural and Social Studies

LIGHTNING AND LIGHTNING FIRE

Central Cordillera, Canada



Mark Heathcott

Lightning and lightning fire within the Central Cordillera raise both operational and political concerns. Compared to human-caused fires, lightning fires often occur in remote areas with poor access and account for most of the area burned. They are costly to manage and pose serious safety concerns for fireline personnel. Political ramifications are also significant, especially within national parks that have a policy of minimal interference to ecological processes such as fire. The question of whether the only "natural" fire is lightning fire may cause difficulty for park managers tasked with fire protection as well as ensuring ecological integrity. The past role of cultural burning practised by aboriginal people complicates the issue. Can lightning fire alone cycle ecosystems similar to long-term conditions? How can park managers, responsible for both fire protection and ecological integrity, decide when it's appropriate to suppress lightning fires or when it would be beneficial to conduct prescribed burns? Which strategy is riskier in fire-dependant ecosystems: random ignition by lightning or planned ignition by managers? To answer these questions and select appropriate fire management strategies, park managers must understand park fire regimes, including those related to lightning.

In the mid-1990s, Parks Canada's Western Fire Centre reviewed and analyzed lightning fire, lightning strike, fire weather, climatic, land cover, and topographic data for the 183,230 km^2 area bounded by 50-54°N, 114-120°W (Alberta-BC Mountains). Data for all lightning fires from 1961 and 1994 were obtained from the British Columbia Forest Service (BCFS), Alberta Lands and Forest Service (ALFS), and Parks Canada. The BCFS and ALFS provided lightning strike data from their lightning location systems for 1989-1994. As both systems detect strikes on either side of the Continental Divide, the two data sets were joined after removing all strikes the BCFS system detected in Alberta and visa versa. Fire weather records (1989-1994) from 108 provincial and federal weather stations were used to determine fire danger for the period, while climate data in the form of Canadian Climatic Norms (1961-1990) were obtained from Environment Canada. Land cover and digital elevation data were obtained from a 1 km resolution North American data base derived from AVHRR data by the United States Geological Survey.

The spatial pattern of over 14,000 lightning-caused fires is striking (Figure 1). The Continental Divide dominates the picture, with high fire density to the west in British Columbia, with significantly lower fire density to the east, in Alberta. The two big east slope national parks, Banff and Jasper, fall in the lightning fire shadow cast by the Divide, with the neighboring Foothills showing increasing fire activity. The west slope parks, Kootenay and Yoho, contain pockets of moderate fire density, while Glacier and Mount Revelstoke

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Research Links

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ARTICLES

DEPARTMENTS

FRANCOPHONES

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

UPCOMING DEADLINES

SPRING 2000—NOV. 26, 1999
SUM./AUT. 2000—MAR. 25, 2000
WINTER 2000—JUL. 28, 2000

EDITORIAL

All agencies involved in protected areas management strive to increase knowledge through research. Often our search is focussed on more conventional means of gathering and analysing data. We sometimes forget that research is also about acquiring new perspectives and opening our minds to the information and values of others. This issue of *Research Links* demonstrates two important keys to enhancing our science in decision making—partnerships and using a variety of information sources.

The articles in this issue illustrate many kinds and sources of information—from traditional knowledge to high-tech satellite imagery—and demonstrate how these kinds of data can be used to enhance our science and decision making. Recently, oral history has become a common source of valuable information in Cultural Resource Management. Darren Keith and Andrew Stewart's article links the knowledge of an Inuit Elder to data from archaeological excavations in the Churchill area. In a similar manner, a review of "corporate" and personal knowledge increased our understanding of the operational and management concerns of avalanche control in Rogers Pass.

The natural sciences are also recognising the value of combining simple and complex forms of data collection. At a time when telemetry dominates research on large animals, simpler solutions can sometimes be overlooked. The cougar tracking study allowed researchers in Banff National Park to evaluate wildlife passage structure use by this large carnivore. Tree ring chronology, a staple of forest research for decades, allows researchers to determine not only the age of trees and stands, but to infer climactic variations over several hundred years. In addition, sophisticated electronic scanning allows us to track individual lightening strikes over broad areas and to correlate fires to site characteristics.

The research projects features in this issue illustrate the importance of partners in research. The knowledge of aboriginal people can be used in a variety of aspects from interpreting historical events to augmenting fire management histories. Sharing expertise with other federal, provincial and territorial governments and agencies provides us with the means to increase expertise and management effectiveness for all. Partnerships also help us to understand the needs and values of others as we learn to manage in broader landscapes. Similarly, working with academic institutions brings new ideas and a broad range of expertise to many park projects.

Parks Canada has come a long way in valuing and using research. Our work is not done. By opening new avenues, we broaden not only the information we can use, but the partnerships and support we need to get there. Many opportunities are exemplified throughout this issue of *Research Links.*

Gail Harrison
Editor, Research Links
Ecosystem Services, Western Canada Service Centre, Calgary.

Using Satellite Imagery
for Forest Fragmentation Analysis

Murray Peterson

Mount Revelstoke and Glacier National Parks (MRGNP) are proposing an ecological integrity monitoring program to address fragmentation of old growth forests in the interior wetbelt of the Columbia Mountains, the wettest inland temperate rainforest in the world. A research project conducted by the Department of Geography, University of Calgary (Medina Deuling and Dr. Steven Franklin), is characterizing disturbance patterns and changing forest metrics of old growth forests within the home range of a sub-population of mountain caribou, a threatened species found only in BC.

MRGNP represents the Columbia Mountains Natural Region. The British Columbia biogeoclimatic classification is Interior Wet Climatic Region (Braumandl and Curran 1992); comprising western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*) ("cedar/hemlock") in the valleys below 1250 meters; and Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) ("spruce/fir") within the higher elevations. The area is dominated by old growth forests older than 180 years with a natural disturbance regime consisting of avalanches, insects and disease, wind, and infrequent stand-replacing fires. Current understanding of habitat selection by mountain caribou, shows they rely on epiphytic lichen in old growth forests when all other food sources are unavailable (McLellan *et al*. 1994).

Forestry has been a major industry within the Columbia Mountains since the 1950s. Logging in the BC interior became a significant landscape disturbance in the late 1960's (MacDonald 1996) and accelerated in the Revelstoke area through the 1980s. Harvesting has focused in the low valley old growth forests. These forests are critical early and late winter habitat for mountain caribou, providing shelter, food sources and access between remaining habitat (Morris 1995).

This project is developing an alternative database for habitat mapping in response to a concern that the remaining old-growth caribou habitat could become highly fragmented. The hypothesis tested is that fragmentation of this forested habitat is occurring outside the boundaries of MRGNP as a result of timber harvesting and wildfires (Deuling *et al*. 1999). The objectives of the study are to: 1) develop and apply a classification methodology to map important habitat and disturbance units; 2) identify, document, and analyze changes in forest cover type and stand age class distributions that have occurred between 1975 and 1997 from timber harvesting and natural disturbances; and 3) quantify and assess the degree of forest fragmentation occurring between 1975 and 1997 within the forested habitat, and within the old growth forest of the cedar/hemlock. The study area included the home range of sub-population of mountain caribou (*Rangifer tarandus caribou)*

METHODOLOGY

LANDSAT Thematic Mapper (TM) multispectral imagery from 1997 and LANDSAT Multispectral Scanner (MSS) imagery from 1975 was selected to classify habitat communities, identify avalanche paths, fire and forest harvesting disturbances and identify changes in cut block patterns from 1975 to 1997. The TM imagery was converted to a Tasseled Cap transformation and the wetness index used as a measurement of canopy structure. Cohn and Spies (1992) found that the Wetness index of the Tasseled Cap could reliably identify stand structure attributes in closed forest canopies.

A classification procedure involving the integration of GIS and Remote Sensing in a Hybrid Decision Tree Algorithm (Deuling et al., 1999) was then used to classify habitat units and disturbances. Disturbance classes and change in land cover between 1975 and 1997, were identified using a combination of GIS attribute selection and a brightness differencing technique. Forested areas were split into tree species composition classes by a Maximum likelihood Classification (MCL) algorithm.

Disturbance features were classified as recent cuts, recent burns, recent disturbances with an unknown agent, or immature forests. Quantifying and analyzing changes in forest cover from 1975 to 1997 required a temporal map set

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Thank You

THANK YOU TO OUR DEPARTING EDITORIAL BOARD MEMBERS!

We take this opportunity to thank Chuck Blyth and Lawrence Harder for their assistance as members of the *Research Links* Editorial Board.

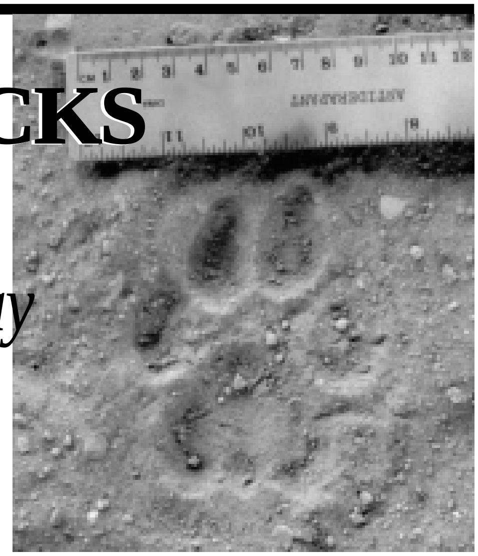
Chuck Blyth's term on the Editorial Board was short but productive. We'll miss his enthusiasm and personal anecdotes. We wish him well in his new position as Field Unit Superintendent Nahanni.

We also bid a fond farewell to Lawrence Harder, Professor of Biology at the University of Calgary, who provided us with three years (nine issues!) of constructive comments, suggestions and the occasional dry pun. Goodness knows he reads enough graduate and undergrad research to satiate his hunger for editing. We consider ourselves fortunate to have benefited from his expertise.

COUGARS MAKE TRACKS

for wildlife passages on the Trans-Canada Highway

Banff National Park



A cougar track at one of the wildlife passages along the Trans-Canada Highway in Banff National Park. Differentiation of individuals by their tracks is a promising technique in wildlife conservation.

Claire Gloyne and Anthony Clevenger

From February to June, 1999, Banff National Park (BNP) undertook a study looking at cougars (*Puma concolor*) and the Trans-Canada Highway (TCH), as part of a wider research project that is monitoring road effects on wildlife in BNP (Clevenger 1998). One of the key aims of the cougar study was to differentiate between individual cougars by measuring their tracks at the 24 wildlife crossing structures along the TCH. Other large carnivores in the Bow Valley have been studied extensively, but little is known about the status or life history of the cougar in BNP. Jalkotzy and Ross (1991) report sightings of cougars in Waterton Lakes, Banff and Jasper National Parks and comment that knowledge of the populations in each park remains sketchy.

Between November 1996 and January 1999, cougars used the BNP passages 165 times, or roughly 50-60 times per year (Clevenger, unpubl. data). The cougars' frequent use of wildlife passages provided an ideal opportunity to learn more about the cougar population in BNP. Researchers can determine whether cougars prefer to use a particular type of wildlife passage, whether there is any interaction between cougars and humans at the passages cougars use most frequently, and whether there are any seasonal patterns in cougar use of wildlife passages (Clevenger and Waltho 2000, Gloyne 1999).

The frequency and seasonality of wildlife passage use provide little information about the cougar population or home ranges. Researchers need more information to conclude whether individual cougars show territorial behaviour toward the passages, suggesting that they have incorporated wildlife passages into their home ranges. (Logan 1986). This information can be obtained by intrusive methods such as capturing and radio-marking, or by non-intrusive tracking studies.

Varying terrain and substrate conditions can make it difficult to differentiate between individual cougar tracks (Smallwood and Fitzhugh 1993, Grigione et al. 1999). However, the level terrain and consistent substrate at all the wildlife passages provided a unique opportunity to evaluate differentiation techniques, gain valuable information as to the status of the cougar population in the Bow Valley, and study how cougars use the passages. If found to be effective, tracking can provide a cost-, time- and labour-effective means of obtaining information often acquired through radio-marking.

METHODS

Tracking sections (2 x 4 m) have been installed at both ends of underpasses to record use. Tracking material is a dry, loamy mix of sand, silt and clay, 3 to 4 cm deep. At 2 to 3 day intervals each underpass is visited and data collected. Through-passages are recorded for individuals if tracks in the same direction are present on both tracking sections. Tracking sections are then raked smooth in preparation for the next visit. Whenever we found clear cougar tracks, we traced them carefully on acetate sheets with permanent markers. In each instance, researchers traced as many tracks as possible within one continuous track set that clearly belonged to the same individual.

We adapted a technique, originally developed by Zielinski and Truex (1995) to differentiate between fisher *(Martes pennanti)* and American marten *(M. americana)* tracks, for use on cougar tracks. The technique involves constructing a Cartesian grid over the track, then locating a standardised point or centre of origin for every track. The centre of origin was used as a point from which to generate measurements. Fourteen separate measurements were taken from each track, including the angle between the toes, distance between the outer toes, length from lead toe to central heel lobe, and the area of each toe and heel pad (Figures 1A and 1B). After testing all the track measurements using multivariate analysis of variance (MANOVA), we found a significant difference between the measurements obtained from left and right hind feet. Left hind tracks were used in the analysis, as they were present in the greatest number in the majority of track sets.

The track data was analysed using several statistical tests to differentiate among tracks made by separate individuals. The data were first analysed using MANOVA. Tracks of a captive cougar (collected from an individual held at the Calgary Zoo), were included to check that the analysis could identify a track set known to be different from those collected in Banff. The analysis was run a second time with the tracks of the captive cougar excluded to highlight the more subtle variations among the Banff track sets.

The second test was discriminant function analysis (DFA), which requires that at least two different predefined groups (track sets) are entered into the model. Further unknown groups (tracks sets) were entered and classified either as belonging to one of the existing groups or as representing a new group. We used the results from the MANOVA to assist us in selecting two track sets we were confident were made by different individuals to form predefined groups for use in the DFA. Circumstantial

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Lightning and Lightning Fire

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National Parks fall into British Columbia's high fire density zone, which seems to follow the big, deep, valleys.

Typical of wildfire in Canada, just a few fires (2% of 14,000 fires) accounted for most of the area burned (95% of 180,00 ha.). Three of these big fires, 2 in the Rocky Mountain Trench of British Columbia and 1 near Edson, Alberta, accounted for about 25% of the area burned in the 34 year record. The timing of peak fire occurrence and large area burned is also interesting. Fire occurrence and area burned are out of phase, with area burned peaking weeks earlier than peak fire occurrence, especially in Alberta. This pattern could be related to the seasonal rhythm in the foliar moisture content of conifers, which shows a pronounced spring dip. Crown fire initiation and crown fire spread rates are enhanced by low foliar moisture. Therefore, fires would tend to be larger prior to conifer bud flush. Additional seasonal analysis pointed to the possibility of this distinct spring sub-season, as well as early summer, late summer, and fall sub-seasons. Seasonality has important implications for the involvement of forest fuels in fire behavior, the severity of fires, plant mortality, and plant recruitment.

Interestingly, the pattern of lightning strikes alone does not explain the pattern of lightning fire (Figure 2 & Figure 3). From 1989 to 1994, over 545,000 cloud-to-ground lightning strikes were recorded in Alberta, producing 377 documented fires, whereas in British Columbia about 166,000 strikes produced 3,432 fires. In other words, lightning effectiveness in Alberta was about 1 fire for every 1,400 strikes, while in British Columbia there is about 1 fire for every 50 strikes. This weak correlation of lightning fire density and lightning density suggested the existence of additional variables controlling the spatial distribution of fire. Along with strike density, slope aspect, slope angle, elevation, land cover, and fire weather were used in an attempt to explain fire density. The results of these analyses indicate that within British Columbia, elevation, distribution of strikes, fire weather, and land cover were strongly correlated to fire density, although the analysis points to the presence of other, unaccounted for factors affecting the spatial distribution of fire. In Alberta none of the variables were strongly correlated to fire density, although the distribution of strikes, land cover and fire weather were identified as possible controlling agents.

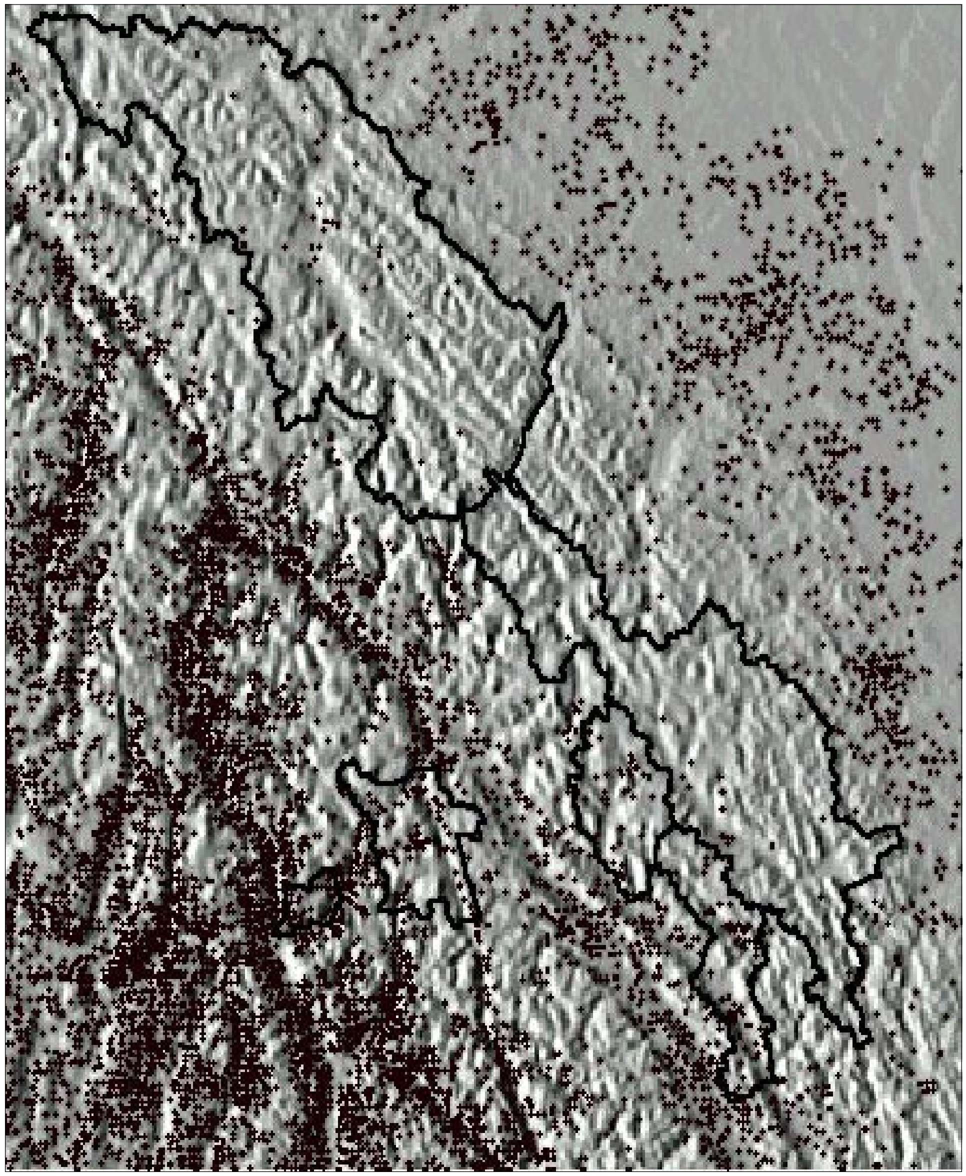

Figure 1. Lightning fires along the Continental Divide, 1961-1994 (Banff, Jasper, Yoho, Kootenay, Mt. Revelstoke and Glacier National Parks outlined)

The observed patterns of lightning and lightning fire have a number of implications for park management. First, both lightning and lightning fires are rare events east of the Continental Divide in most of Banff and Jasper. Fire protection implications are relatively clear: protection resources and strategies in these parks should focus primarily on human-caused fire as the probability of lightning fire is low. Lightning fire is much more common in Kootenay, Yoho, Glacier and Mount Revelstoke National Parks. Here, fire protection resources and strategies should include criteria which recognize the increased incidence of lightning fire.

Compared to fire protection decisions, ecological management decisions are much more challenging for these mountain parks. The difficulty arises from national parks mandate which includes goals for both minimal interference to ecological processes such as fire, and for protecting values at risk from fire. The dual mandate means park managers must first describe ecosystem states and processes, then select adequate objectives for fire that respect both goals.

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Speaking of Avalanches...

"It's obvious when you're working with people who have been doing this job for a long time that they have developed a real feel for it, and it's more than being able to look at numbers or look at weather. There is a sixth sense that they have developed about the snow. That's part of the interest of the job – its not cut and dried, you can't do it by numbers. There's always going to be a portion of it that's magic, that's alchemy."

- Excerpt from the interview of John Kelly, Senior Avalanche Forecaster, July 21, 1999 -

Shelly Funston

Parks Canada staff accumulate a vast store of contemporary and historical information while living and working in the National Parks. Staff relocation or retirement, therefore, results in a loss of information and "corporate memory." As Frieda Klippenstein noted in the Summer/Autumn 1999 issue of Research Links ("On a New Approach to Heritage Presentation at National Historic Sites Vol. 7 No. 2), to "*own*" history, people must participate in it. The Mount Revelstoke and Glacier (MRG) Oral History program is actively preserving the history of the parks by recording the memories and experiences of former and current staff. Oral history is an excellent method of data collection because it adds to information in the documentary record, allows for personal and anecdotal information, and includes Park staff in the creation of their own history. As a pilot project, the MRG Oral History program is collecting oral-historical information of the Glacier National Park Avalanche Control Program. The technical aspects of the avalanche control program are well documented (see Schaerer 1995, 1998), but oral-historical information is required to examine the personal experiences of the people associated with avalanche control in the Rogers Pass.

Avalanches are among the defining features of Glacier National Park: a result of heavy snowfall and steep v-shaped valleys. The story of the Rogers Pass, and indeed its designation as a National Historic site, are linked to human interaction with avalanches along this transportation corridor. The success of the park's current avalanche control program, contrasted with the potential threat to lives and infrastructure, is remarkable: in the 37 years since the Trans Canada Highway opened, only two lives have been lost to avalanches. Avalanches affect Park management, visitor use, public safety and resource management. This strong human element is one reason why avalanche control in the Rogers Pass was selected as a test case for recording personal experiences and "corporate memory."

The avalanche control project will test oral-historical techniques to ensure that they meet the needs of this program, and may function as a starting point for more intensive oral history work. The project also meets goals set in MRG's Cultural Resource Management Plan and the Rogers Pass National Historic Site Commemorative Integrity Statement. The designation of the Rogers Pass as a National Historic Site focuses on its role as a transportation corridor during the period 1881-1917, but the Commemorative Integrity Statement emphasizes that presenting the site's evolution promotes a better understanding of national significance. The avalanche control program has played a significant role in the operation of the transportation corridor through the Rogers Pass, and information gained from oral history interviews will be valuable in detailing the site's evolution.

BACKGROUND

The Canadian Pacific Railway (CPR) first attempted to control avalanches in the Rogers Pass, a critical route through difficult terrain. Initial surveys during the 1880's indicated that frequent and widespread avalanches plagued the rail line through the Pass. The technology of the time favoured a reactive rather than proactive approach by the railway – measures for avalanche control were not created until *after* the line had been completely shut down during its first winter of operation, 1885-86. The following spring, CPR realized that they could not operate the line under those conditions and constructed retaining walls to channel avalanches away from the line or over covered sections of track. These methods proved insufficient, and by 1917 the CPR was forced underground, through the Connaught tunnel, to ensure the safety of the line. For almost forty years, the Rogers Pass remained a dangerous area in winter, swept from all sides by avalanches that roared down the steep mountainsides at up to 250 km/hour.

PARKS CANADA AND AVALANCHE CONTROL

The construction of the Trans Canada Highway (TCH) through the Rogers Pass required Parks Canada to re-evaluate avalanche control methods. Stronger measures were needed to ensure public safety if a major road was to operate successfully through the Pass. In 1948, the National Research Council of Canada invited Swiss researcher Marcel de Quervain to make observations of avalanche activity along the proposed route of the TCH. Initial studies indicated a high hazard to the TCH through the Rogers Pass, predicted by a combination of factors: the number of active avalanche paths, the frequency of avalanches which covered the proposed route, and the predicted high volume of traffic at all hours.

During the late 1940's, the prevailing custom in highway engineering was to build the highway first, and deal with avalanche problems after they arose. In an unprecedented move, the Canadian government created a system of avalanche control in conjunction with the design of the highway. In 1956, Swiss engineer Peter Schaerer was hired to assist with the design of the Rogers Pass avalanche control program. A series of static defenses, including berms and channels, was constructed to guide avalanches over snowsheds covering the most hazardous areas of the highway. Introduced by Schaerer, the use of artillery, including 105mm howitzers and various mortars, was evaluated prior to the opening of the highway as a cooperative program between Parks and the Canadian military.

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The Churchill Oral History Project:
Interviews with Inuit Elder John Arnalukjuaq

Figure 1. Darren Keith (right) interviewing Elder John Arnalukjuaq at Prince of Wales Fort near Churchill. David Ukuak (centre) translates.

Darren Keith and Andrew Stewart

The Churchill Oral History Project was designed to learn more about the history of Inuit peoples of western Hudson Bay and to enhance the interpretation of First Nations history at national historic sites in the Churchill area. By recording Inuit elder John Arnalukjuaq's memories of life in the Churchill district, project researchers gained information about Inuktitut place names in the region, recorded stories about John Arnalukjuaq's experiences beluga whaling, and explored the historical association of Inuit peoples with the Churchill River.

John Arnalukjuaq, the subject of the Churchill Oral History Project, was interveiwed in Churchill between July 20th and 26th, 1998. His insights regarding Inuit land use around and north of the Churchill area bear on specific archaeological features on the west peninsula, and on historically recorded events and people. John was interviewed in town, during visits to the Churchill west peninsula where Prince of Wales Fort and Sloops Cove national historic sites are located, and at traditional Inuit sites along the Hudson Bay coast east of Churchill. Documentation of this oral history includes place names keyed to locations on three 1:250,000 scale maps and translated transcripts from videotaped narratives. Extensive field notes were taken during the week-long project and were used in compiling the final report.

John Arnalukjuaq, was born in 1924 at Nauhaaq, a large hill on the south side of Baker Lake just to the west of the mouth of the Kazan River. He considers himself a *Hauniqtuurmiut* (a person of the Wilson River), based on where his parents were from, though he lived for many years in the Whale Cove district. John spent time trapping inland in the Tulimalujuaq area with a dog team, becoming an experienced hunter. He first went to Churchill before 1940, traveling there with his older brother Qilluq (Remi Kiluk), who is now buried in the cemetery in this northern seaport. In the early 1950s, John spent three summers working with the Adanac Whale and Fish Products Company at Churchill. He lived in Nunalaaq from 1950 to 1962, except for one year, which he spent in Winnipeg recovering from polio.

Archaeological knowledge of the Churchill area is derived from mapping projects and field studies of hundreds of archaeological features over the last 30 years, particularly on the west peninsula. Historical land-use knowledge of this region is largely based on archival materials found in the Hudson's Bay Company Archives and on other unpublished records, such as travel journals and explorers' observations. Records from the late 19th century were reviewed in the course of this project to identify specific Inuit names and to assess the seasonal timing of Inuit activities and visits to the Churchill Post during this period.

The dense distribution of archaeological features and artifacts on the Churchill west peninsula indicates a 3000-year history of human settlement in this area. Camp sites that overlook Seahorse Gully on the peninsula date back to about 1000 B.C. Distinctive dwelling outlines and artifacts such as flaked stone hunting weapons and bone and wood-working tools have been identified as belonging to the Palaeo-Eskimo period between about 2000 B.C. and A.D. 1000.

A much bigger area, extending from Eskimo Island (immediately north of Prince of Wales Fort) to the southwest shore of Button Bay, contains dense concentrations of boulder features related to historic Inuit occupation of the area. These features include boulder tent rings, graves, fox traps, kayak stands, children's play areas and caches for whale and seal oil and meat. Many of these features are similar to those found at other Inuit sites north along the Hudson Bay coast and in the interior. At one site a few circular depressions with possible entrance tunnels may be early Inuit (Thule) winter houses dating from 500 to 1000 years ago. Collectively, these features attest to repeated occupation of the west peninsula by Inuit over a number of centuries.

Specific archeological features were observed at two known sites during our visit with John Arnalukjuaq. Eskimo Island contained a small, isolated cache and a tent ring with adjacent caches. The cache is a semi-subterranean, rectangular "box" with three distinctly-formed sides. Long boulder slabs are placed on edge to retain the surrounding gravel substrate, enclosing an area about 50 x 40 cm and 15 cm deep. The fourth side is open. Rich vegetation growth over the feature floor is possibly a result of leaching of cache contents. According to John Arnalukjuaq, caches

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Churchill Oral History Project

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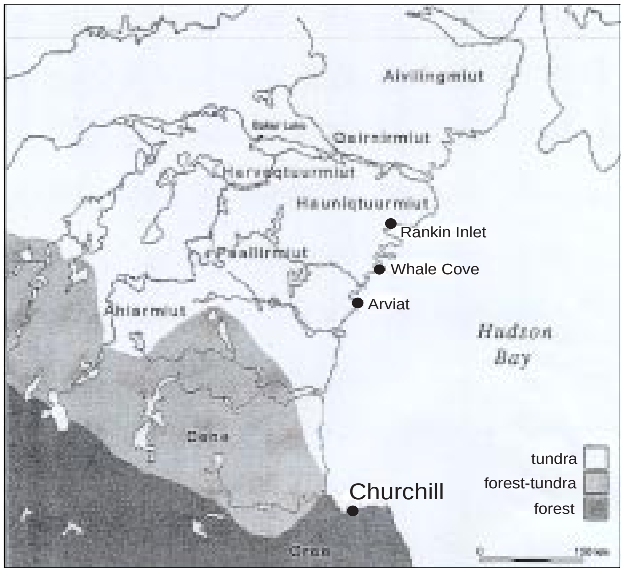

Figure 2. Traditional Inuit groups of western Hudson Bay.

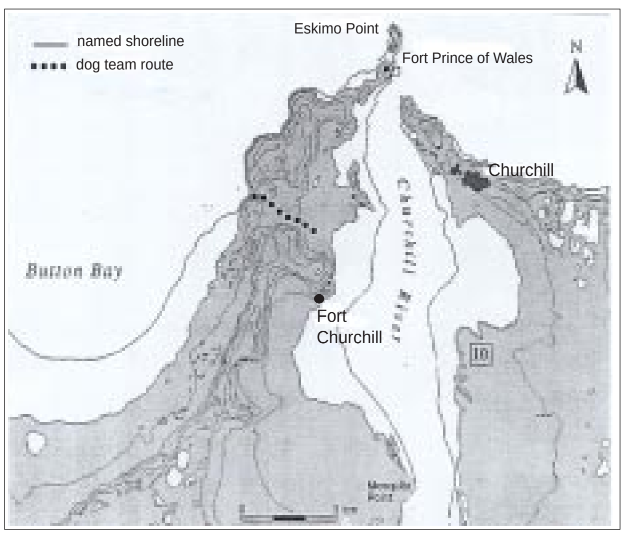

Figure 3. Map depicting the mouth of the Churchill River.

of this sort were designed to hold whale and seal oil stored in skin bags. The oils may have been used for household consumption or for trade to the Hudson's Bay Company. Also at this site (and other sites on the west peninsula) are tent rings located on cobble beach ridges where the cobble substrate provided good drainage.

John Arnlukjuaq was also taken to a Button Bay site containing hundreds of features. One tent ring at that site contained the distinctive Inuit "three-stone" hearth, or *kik&u*, just inside the entrance (*paa*) to the ring. John recognized one feature, not previously identified, as a hide-drying ring called a *piruaq*. This is a loose, light ring of cobbles or small boulders located on sloping ground, the slope allowing water to run off the hides. He also commented on the clusters of white quartzite pebbles and cobbles that have been recorded by archaeologists at several sites on the west peninsula. They might have been collected by children for play, but quartzite was also a fire-stone (*tunuujaq*). These rocks were sometimes collected during summer for starting fires in winter. John described two types of boulder fox traps not observed during our visit, but traditionally used by the Inuit. One is a deadfall trap (*ajagutaq*) in which a boulder falls on the animal. The other is a chambered trap (*pullat*) with a suspended door that closes off the entrance.

The archaeological record supports the ancient and ongoing relationship of the Inuit and their predecessors with the Churchill area, although accounts by early European visitors to the region do not confirm this relationship. Though the Danish explorer Jens Munk, who arrived at the mouth of the Churchill river in 1619 and wintered on the west peninsula, saw evidence of summer campsites, it is unclear from his description whether these camps were Inuit or Indian. A century later, in 1719, the HBC established a post on the Churchill River from where they sent sloop vessels north along the coast to trade with the Inuit. The sloop trade brought in furs, oil and blubber. The HBC's interest in marine mammal blubber was, in part, the reason for setting up a post at Churchill, and would continue to be the catalyst for Inuit-European interaction there well into the 20th century.

In 1730 construction began on Prince of Wales Fort, a huge stone fortress at the point on the west side of the river mouth. This fort replaced the wooden post further upriver and continued the sloop trade with the Inuit to the north. Along with the Company's pursuit of the fur trade in the region, whales were caught in the Churchill River, their oil sent to England with the returning supply ship. In 1782, post governor Samuel Hearne surrendered the fort without resistance to the French captain Comte de la Perouse whose soldiers mined the walls of the fort and set fire to the buildings. The Inuktitut name for the fort is Unatarvi'vinni'juaq, which means "place where a battle was fought." John Arnalukjuaq explained that this name was a direct result of the fort's history:

There was a battle that took place at the Fort a long time ago. There were shots being fired from the north side and the walls were ruined. Some local people from Arviat fixed up the fort [in the 1930s]. Those who went to fix up the fort are still around today in Arviat. The repair took place in the spring time. The fort was attacked from both sides, from the north and the south. There were spikes everywhere around the fort. Those who tried to make their way to the fort, when they stepped on those spikes, they fell over and couldn't walk, and they lost the battle. Those spikes, even if they were stepped on, no matter what happened, they [the spikes] would still end up standing. After the battle they used magnets to find where the spikes were and remove them all. After those spikes were removed, then Inuit started showing up at the Fort area.

This extraordinary account, which differs from traditional European descriptions of the destruction of Prince of Wales Fort, captures an Inuit version and oral tradition that preserves a two-century old memory of the attack on the fort.

When the HBC returned to the Churchill River the following year, a wooden post, Fort Churchill, was established five miles upriver. The Company continued the white whale fishery at the mouth of the river, but in 1790 put an end to its sloop trading voyages northward. Instead, the HBC provided the Inuit with gifts as incentive to visit the Churchill post, and during the 19th

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Churchill Oral History Project

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century as many as 600 Inuit visited or worked at the fort annually. Visiting Inuit hunted and traded seal and white whale blubber and meat, and traded caribou, fox, wolf, wolverine and muskox for tobacco, ammunition and other goods. In addition, Inuit were temporarily hired to haul wood to supply the post for the winter and, until 1820, for construction material. Diminishing manpower at the fort in the early 19th century meant that the whale fishery at the mouth of the Churchill River was not as efficient and profitable as it once was. The abundant white whales at the Seal River to the north were attractive to the post. The shallow mouth of that river favoured the Inuit method of hunting them from kayaks using harpoons with attached lines and floats for recovery of the carcasses. So important was the Inuit whale hunt at the Seal River that the HBC men would sometimes refuse to trade with the Inuit until they had completed this job. This pattern of seasonal land use, established early in the 19th century, continued until the 20th century. Inuit would come to Churchill in the spring by dog-team early enough to hunt seals in Button Bay and Hudson Bay, their oil traded at the Churchill post.

...as many as 600 Inuit visited or worked at [Fort Churchill] annually. Visiting Inuit hunted and traded seal and white whale blubber and meat, and traded caribou, fox, wolf, wolverine and muskox for tobacco, ammunition and other goods.

Most Inuit camped on the west peninsula, particularly at Eskimo Point north of the old stone fort. This point is known as Nuvuguhiq in Inuktitut. They also camped on the Button Bay coast near Seahorse Gully, an area of the coast known as Adgu&iniq . Traffic between Nuvuguhiq and the post buildings at Qupilruqtuuq created a trail which is still visible today. Before the sea ice went out in spring, the ocean off Button Bay was a favourite sealing area for the Inuit. A recently deceased Arviat Elder, Ujaupik (Margaret Aniksak), camped at Adgu&iniq with her father, Aupa'naaq, in the early 1900s. Aupa'naaq used to work for the HBC and would go to the east side of the river to hunt and to gather wood. John's own grandfather, Arnajuinaq, used to tell him how he also lived on the west peninsula at Nuvuguhiq and Adguinniq. While they were there, they would hunt with the Chipewyan for geese for their own needs.

The Inuit that came to Churchill for the spring and summer to hunt whales on the Churchill and Seal Rivers would leave for their caribou hunting grounds in August. Beginning in the 1890s many Inuit caught rides with HBC boats that traveled to Marble Island on a regular basis to compete with the American whalers there for the trade with Inuit. Those who did not go by coast boat would lash their kayaks together (a practice known as *pauvigiit)* to transport equipment north to Hubbard Point, which is named Qikiqtarjuit in Inuktitut.

Inuit also traded at the Churchill post in winter, often staying in the area for only one or two days. They traveled by dog team from the Keewatin District to Churchill with furs to trade, crossing the ice on Button Bay and stopping on the west side of the west peninsula. Here, they could haul their sleds across the peninsula through the low passage formed by Seahorse Gully, called Itivvaq in Inuktitut. This winter trade continued well into the 20th century. Even after trading posts were established further north, Inuit continued to come to Churchill for the greater choice in trade goods and better prices.

The trade in beluga whale oil that had played a significant role in the history of the HBC on the Churchill River since the early 18th century, continued into the 20th century, although the demand for oil declined with the diminished requirements of the European markets. Inuit continued to be involved in the hunt, trading the whales they caught while camping at Nuvuguhiq. The HBC ended its whaling practice in 1929 after 200 years. However, commercial whaling was taken up by other companies and continued into the 1960s. In the late 1940s and early 1950s, the Adanac Whale and Fish Products Company operated at Churchill and employed people to catch and process whales at a factory located on the east peninsula. John Arnalukjuaq and other Inuit caught whales for the company during this period. He relates how whales were spotted and tracked in the murky water of the river's mouth:

> *...it is hard to get a beluga whale right away, because the waters of the bay are murky. But we would follow the ripples on the water from the whale's tail. We would follow the ripples when we couldn't see the whale itself because of the muddy water. You couldn't see [the whales] when they were in deeper water. You can see them when they come up for air. They are barely visible when they are in deep water. Sometimes the whales would end up in deep water and, the waters being murky, we would lose them....When they came up for air and when they were close we would watch which way the whale was swimming....The whales we caught we would bring to the whaling station where they were hauled in by the Qablunaat ("white men").*

Historic sites at the mouth of the Churchill River, like many sites within the national historic sites system have an association with Aboriginal peoples and it has become common practice to consult Inuit and other First Nations people in the development and interpretation of these sites. In some cases, however, the local population may not include all the Aboriginal groups who were associated with the history of a particular site. In the case of Prince of Wales Fort National Historic Site, the nearby town of Churchill has most recently been home to Cree and Dene peoples. The history of the fort, and the role of Aboriginal peoples in this history, have been interpreted primarily in consultation with Cree and Dene groups. The Inuit, due to the politics of the late 20th century

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RESEARCH H

WEST SLOPES BEAR RESEARCH PROJECT UPDATE

The West Slopes Bear Research Project is now in its sixth year. The study area is in the upper Columbia River near Golden, BC and includes portions of Glacier and Yoho national parks as well as extensive areas of provincial lands. This area spans a variety of habitats, and management systems and is, in effect, a microcosm of the developments occurring in bear ranges across British Columbia and elsewhere.

The West Slopes project is using a new DNA fingerprinting technique to track bear population changes in forested environments without capturing individuals. Hair left by free-ranging bears attracted to scent stations, is analyzed using this technique to to identify the species and sex of individual bears and to monitor bear numbers.

Researchers continue to monitor as many radiocollared adult female grizzlies as possible to refine estimates of adult female survivorship and apply stable isotope analysis to identify bear diet ratios. Graduate students have been researching the impact of highways and railways on grizzlies, bear use of forest harvest areas and avalanche paths, and genetic fracture zones and population definitions.

From the beginning of the West Slopes project, Parks Canada (Glacier, Kootenay, Yoho, and the Research Division in Ottawa) has been cooperating with the Columbia Basin Fish & Wildlife Compensation Program, the BC Ministry of Environment, Lands and Parks, BC Ministry of Forests, the Friends of Mount Revelstoke and Glacier, and the Universities of British Columbia, Calgary and Alberta. Dr. Curtis Strobeck's DNA laboratory at the University of Alberta is a key component of this project.

Ecosystem Management Fact sheets

Mount Revelstoke and Glacier National Parks have produced a series of Fact sheets on Grizzly Bears, Mountains Caribou, Neotropical Migrant Birds, and Inland Rainforests to highlight issues in Ecosystem Management in the Columbia Mountains. These are available from the park by calling 250-837-7500 or by viewing the Columbia Mountains Institute of Applied Ecology website (www.cmiae.org)

Michael Morris, e-mail: Michael_Morris@pch.gc.ca

A bear leaves traces of fur on barbed wire at a scent station. DNA from the fur is used to identify the species and sex of individual bears and to monitor bear numbers.

SONGBIRD MONITORING IN BANFF NATIONAL PARK

During the 1999 the Bow Valley Naturalists established a Monitoring Avian Productivity and Survivorship (MAPS) station to monitor landbird populations at a wetland complex in the Montane Ecoregion of Banff National Park. The MAPS Program gathers data through standardized, constant-effort mist-netting during the breeding season.

The objective of MAPS is to provide long-term population and demographic information on target passerine species at various spatial scales. The program provides annual indices and longer-term trends in adult population size and post-fledging productivity by analyzing the numbers and proportions of all birds captured during the breeding season. Researchers also make annual estimates and examine longer-term trends of adult survivorship, adult population size, and recruitment into the adult population by analyzing mark-recapture data on adult birds gathered at these same stations. These indices and estimates can be used to identify the causes of population changes in the target species, identify conservation and management actions to reverse the population trends of declining species, and evaluate the effectiveness of the conservation and management actions.

At the Ranger Creek station, 283 birds of 37 species were handled during 6 days in 1999. Only 12 juveniles were captured, which suggests that productivity was low, possibly due to inclement weather. The five species captured most commonly were Yellow Warbler (*Dendroica petechia*), Wilson's Warbler (*Wilsonia pusilla*), Traill's Flycatcher (*Empidonax alnorum* and *E. traillii*, not differentiated), Common Yellowthroat (*Geothlypis trichas*), and American Robin (*Turdus migratorius*), in descending order. The capture rate was 79 birds/100 net hours. Banding was done by qualified members of the Calgary Bird Banding Society, with the assistance of 16 local volunteers. Funding was obtained from Parks Canada and the Baillie Fund of Bird Studies Canada.

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IGHLIGHTS

OSPREY RESEARCH IN THE ROCKIES

Recently, osprey eggs from a couple of locations in south-central BC tested positive for high levels of DDE (a metabolite of DDT). The levels approached those known to impair reproduction. The pollutants are picked up by ospreys on their wintering grounds in South America, where they store them in fatty tissue and deposit them in eggs when they return to North America.

Researchers also speculate that some of the pollutants originate in Asia and are carried by prevailing winds to colder climates on Canadian breeding areas where they condense and are trapped in snow until summer snowmelt releases them into the surrounding ecosystem.

Environment Canada, Parks Canada and Alberta Fish and Wildlife began a study in 1999 to determine whether osprey in the Rocky Mountains may be at risk from exposure to organochlorines. In the summer of 1999, researchers collected eggs from eight osprey nests and blood samples from nestlings in 10 nests in Waterton National Park, Peter Lougheed Provincial Park. Banff and Jasper National Parks. Samples were sent to Environment Canada's National Wildlife Centre, in Ottawa, where they will be analyzed for pollutants. Next year, researchers plan to focus on higher elevation lakes and combine results with a BC study that is using satellite telemetry to track the movements of banded osprey to their wintering areas to determine whether organochorine levels are hazardous to osprey in the Rocky Mountains.

Mark Wayland, Wildlife Biologist,
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Researcher Mike Miller and his assistant Ken Symington (with Cyndi Smith looking over his shoulder) take samples from an osprey chick while park visitors watch.

Osprey chick

Photos: Heather Dempsey

EINP'S NEW FOCUS ON LANDSCAPE RESTORATION

The management philosophy of Elk Island National park (EINP) has recently changed and is moving from a species management approach to a broader landscape management approach. This new approach looks at "bigger picture" elements such as vegetation patterns, and the major processes such as fire, grazing and wetland flooding.

EINP is developing a suite of indicator species for monitoring natural resources to determine how the fire, grazing and flooding programs influence the landscape. Park stressors such as air quality, weed invasion, habitat fragmentation and over-grazing area also monitored.

Grazing impact on vegetation is currently monitored using rangeland reference plots, which exclude ungulate grazing through specially designed fences, approximately 60 m x 20 m. Scientists monitor biodiversity and production in these plots to compare the results with grazed areas. This type if research will help determine the proper balance of ungulates and a grazing regime that will complement biodiversity. A considerable effort goes into monitoring ungulate diseases such as Tuberculosis, Brucellosis and Giant Liver Fluke.

EINP is conducting research on insects, amphibians, aquatic and forest breeding birds to develop indicator species. The park is also monitoring ungulate and beaver populations, forest breeding birds, air quality, noxious weeds and forest cover.

It is anticipated that this new research and monitoring program will enhance EINP's ability to monitor and manage the ecosystem to ensure the ecological integrity of the park's Apsen Parkland.

Norm Cool, Park Conservation Biologist and
Kayla Brunner, Ecosystems Communicator,
EINP Tel: (780) 992-2959;
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Cougars Make Tracks

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evidence also influenced group identification. For example, one of the track sets belonged to an adult female accompanied by kittens (whose tracks were also found but too faint to trace). This individual repeatedly used the same set of wildlife passages. A second set of tracks belonged to a cougar at an entirely different passage. We used SYSTAT (1998) for all statistical analyses.

RESULTS AND DISCUSSION

Between February 1 and May 31, 1999, 78 cougar passages were recorded at the wildlife crossing structures, of which only 32 track sets were traced (due to the variable quality of the tracks). We tested fourteen track sets in the final analysis. The number of traced tracks ranged form 4 to 11 per set. The results of the DFA (Figure 2) indicate that four different cougars used the passages. One individual used passages east of Banff, two individuals used passages immediately west of Banff, and a fourth individual used the newly-constructed passages further west.

Sightings of various cougars by members of the warden service and other circumstantial evidence suggest that our results are correct. Cougars are territorial and occupy distinct home ranges, which rarely overlap in the case of males, but sometimes overlap in the case of a male and a female, or two females (Beier and Barrett 1993, Spreadbury et al. 1996). These results show that cougars incorporate the wildlife passages into their home ranges, and are using them as they would any other part of their home range. The findings are encouraging as some people are concerned that wildlife passages force animals in to unnatural contact, thereby increasing the spread of disease. Alternatively, there are concerns that animals might avoid wildlife passages for fear of contact and attempt to climb the fence and cross the highway instead. (Tewes and Blanton 1998).

In this study, DFA in conjunction with MANOVA successfully differentiated among individual cougars on the basis of their tracks. However, circumstantial evidence was extremely helpful in estimating the distribution of individuals in the study area, and it would be difficult to use this tracking technique were such information not available.

The crossing structures were an ideal location for this type of study. We were fortunate that cougars regularly left large numbers of prints on standardised substrate on level ground. Grigione et al. (1999) and Smallwood and Fitzhugh (1993) obtained some useful results despite substrate variability and uneven ground because they had prior knowledge regarding the identity of the individuals. Large sample size was a particular advantage in our Banff study, given the necessity of splitting the data due to statistical differences between the right and left paws. The tracking technique is an inexpensive and non-intrusive means of identifying individual animals and, as we found, can be a valuable tool for answering specific resource management questions.

Further research may reveal ways to overcome the limitations of this tracking technique. Similar techniques are currently being tested on tigers (*Panthera tigris*) in India (Goyal, pers. comm.) Results from the cougar tracking study, combined with information from the long term monitoring of the wildlife passages between Autumn 1996 and 1999, has provided useful insights

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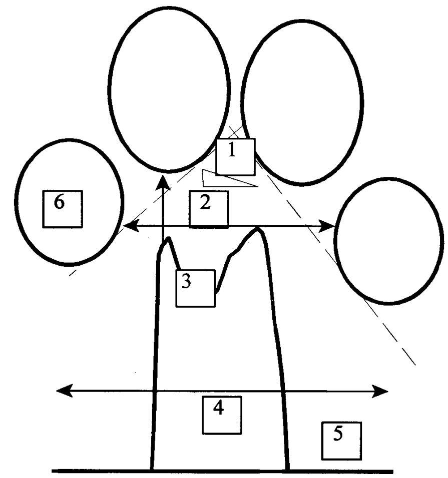

Figure 1A

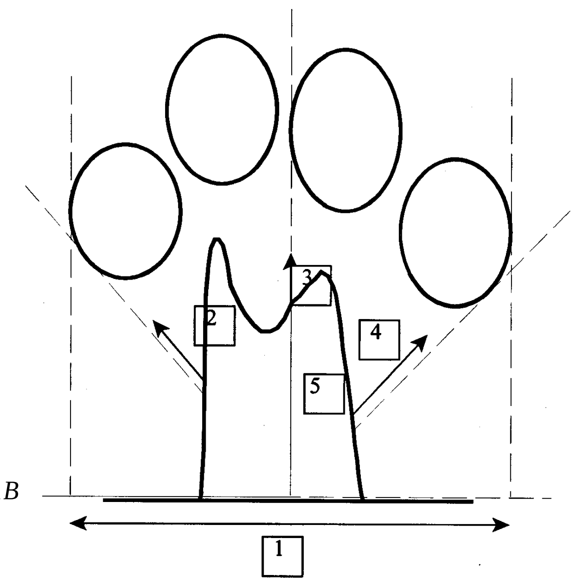

Figure 1B

Figure 1. Measurements of cougar tracks.

A. *Standard method:*
  1) *angle between toes*
  2) *outer toes spread*
  3) *heel to lead toe length*
  4) *heel width*
  5) *heel pad area*
  6) *area of 1st toe.*

B. *Point of origin method:*
  1) *total width*
  2) *left lateral margin length*
  3) *heel length*
  4) *right lateral margin length*
  5) *angle between outer toe pads.*

Cougars Make Tracks

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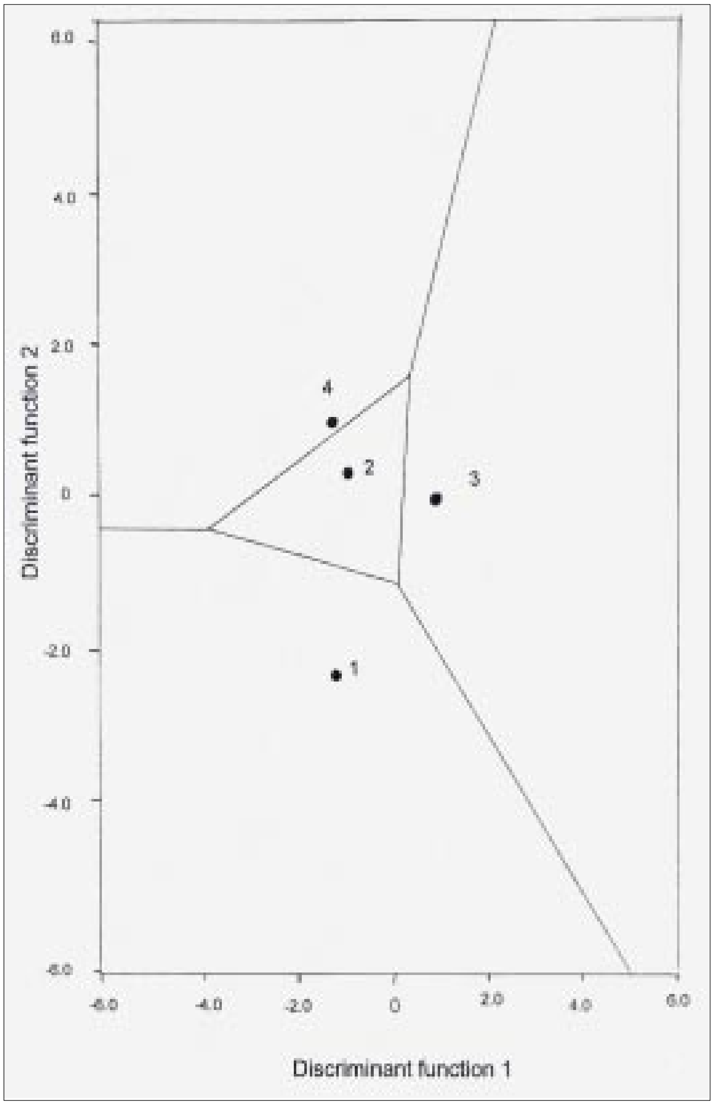

Figure 2. Territorial map showing the four discriminant groups (individual cougars) resulting from the analysis

regarding the effectiveness of the wildlife passages for cougars. A large-scale study (trapping, radio-marking and close monitoring of cougars, particularly in backcountry areas, where a tracking study would be difficult) is required to obtain a population estimate and information regarding the size of home ranges for cougars in BNP.

ACKNOWLEDGEMENTS

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Lightning and Lightning Fire

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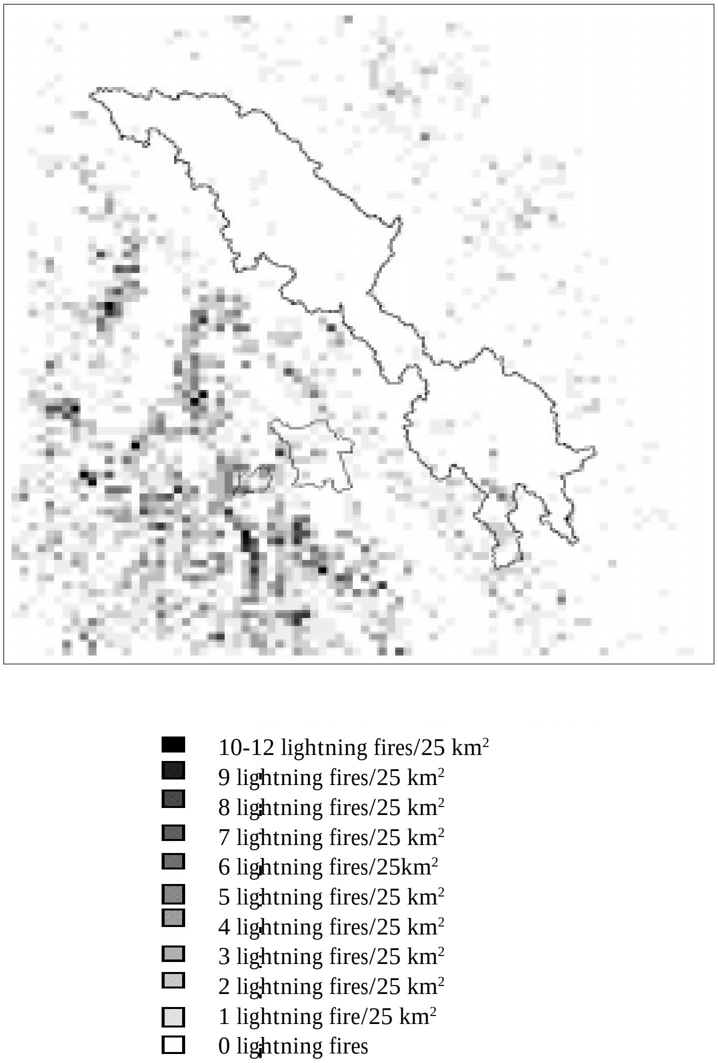

Figure 2. Lightening fire density along the Continental Divide, 1989-1994

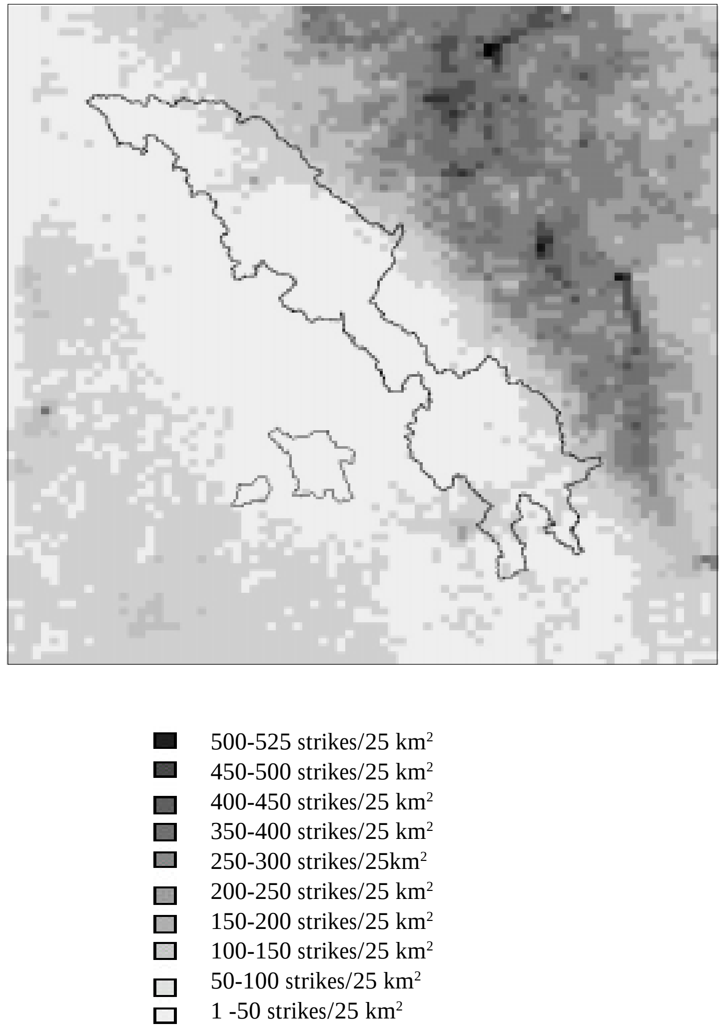

Figure 3. Lightening density along the Continental Divide, 1989-1994

Fire regimes are the best way to describe fires in ecosystems. Key fire regime descriptors include ranges in fire frequency, fire intensity, fire size, fire severity, fire season, and ignition sources. Detailed fire regime analyses for the six mountain parks indicate relatively comparable fire cycles of about 100 to 150 years over the long-term, despite the rarity of lightning fire east of the Divide in Banff and Jasper. Further, park fire histories also show a distinct reduction in area burned and hence much longer fire cycles this century. Some researchers hypothesize that longer 20th century fire cycles are a result of either climate change or fire protection. However, fire climate analysis fails to show any significant change this century. Given relatively constant climatic conditions, it appears that extensive and intensive fire protection is responsible for increasing fire cycle length. It is therefore likely that human-caused fire ignition, including cultural burning practices, was an important ecosystem feature prior to the current fire protection era. The results of this study indicate that lightning alone cannot maintain historical fire regimes in fire-dependent ecosystems with the mountain parks, especially east of the Continental Divide. Management intervention in the form of planned prescribed fires is required for fire regime restoration. Lightning fires may meet management objectives, especially in the parks west of the Divide. However, it must be recognized that managing random ignition lightning fire is much riskier than planned ignition fire. Allowing random ignition lightning fires to burn may compromise both traditional suppression concepts and desired fire effects. Besides, fire's effect is independent of its mode of origin. Does nature really care who starts the fire?

ACKNOWLEDGEMENTS

Jack Wierzchowski, Geomar Consulting, and Mike Flannigan, Canadian Forest Service are co-authors of a technical paper of the same title submitted to the International Journal of Wildland Fire.

Mark Heathcott is with the Western Fire Centre, Parks Canada, Western Canada Service Centre, Calgary.

Millennial-Aged Trees

from Banff National Park

Brian Luckman and Don Youngblut

Alpine environments are classic areas for the study of climate change because they contain a wide range of natural phenomena (e.g. glaciers and treelines) that are strongly influenced by climate and provide easily-detected evidence of climate change. Over the last 30 years, researchers from the University of Western Ontario (UWO) have been carrying out studies of glacier fluctuations, pollen and tree rings within Banff and Jasper National Parks to reconstruct the environmental history of the Central Canadian Rockies. The most precise natural archives of recent environmental changes in this region are developed from tree-rings. The annual ring provides a precisely-dated calendar that enables researchers to assign a specific year to each ring for the life of the tree. Variations in the width or density of the annual ring reflect changes in the tree's environment and therefore, in addition to providing a calendar, the annual ring also contains information about year-to-year changes in environmental conditions. At sites where tree growth is primarily limited by a single climate factor (e.g. summer temperatures at upper treeline, precipitation in very dry areas) variations in ring characteristics can be used to estimate past climate conditions during the life of the tree. One of the major difficulties in studying climate change in the Rockies is that the few available instrumental climate records only extend back to the period between 1890 and 1920. "Proxy" records of temperature and precipitation, developed from tree-ring series, can be used to extend this record back several centuries, thereby allowing the study of a more representative, longer, climate record. Two examples of this type of record are shown in Figure 1.

Mountain areas also provide ideal environments for the occurrence and preservation of old trees. Mountain climates are severe, the trees are often stressed (and therefore grow slowly) and may be growing at the limit of their range (which makes them particularly sensitive to changes in climate). Longevity is also promoted because some of the major causes of tree mortality may be locally reduced in these environments. The patchy distribution of trees, plus the presence of natural firebreaks such as moraines, avalanche tracks, landslides and rivers, reduce the risk of fire and the spread of some pathogens/insect infestations. National Park status also protects old growth from logging activity. Therefore in addition to the intrinsic interest of these old growth sites as indicators of the likely maximum age of individual species, these sites also contain the longest archives for the recovery of proxy climate data with annual resolution.

Over the last 15 years, dendrochronological studies conducted at the UWO have focused on climate change, particularly within the Canadian Rockies. During that time, researchers have assembled an extensive database of tree-ring chronologies, mainly from sites at the upper treeline within national or provincial parks. In the process of developing long chronologies for tree-ring dating and climate reconstruction, we have identified the oldest-known individuals of several tree species within the "Mountain Parks" and probably within the Canadian Rockies.

During the summer of 1998, we visited a site at Saskatchewan Glacier in Banff National Park where we had previously sampled a stand of whitebark pines that were overridden and killed between 1543 and 1862 AD during the "Little Ice Age" advance of Saskatchewan Glacier. At a second site, some distance downvalley, we noted a stand of whitebark pines containing several large individuals that, if sound, would possibly contain significant tree-ring records. The stand grows on a talus slope below a steep bedrock cliff and the large trees occur in isolated groves between snow avalanche tracks. Reconnaissance sampling of this stand in June 1998 (34 trees cored) indicated that several of these trees were of significant age.

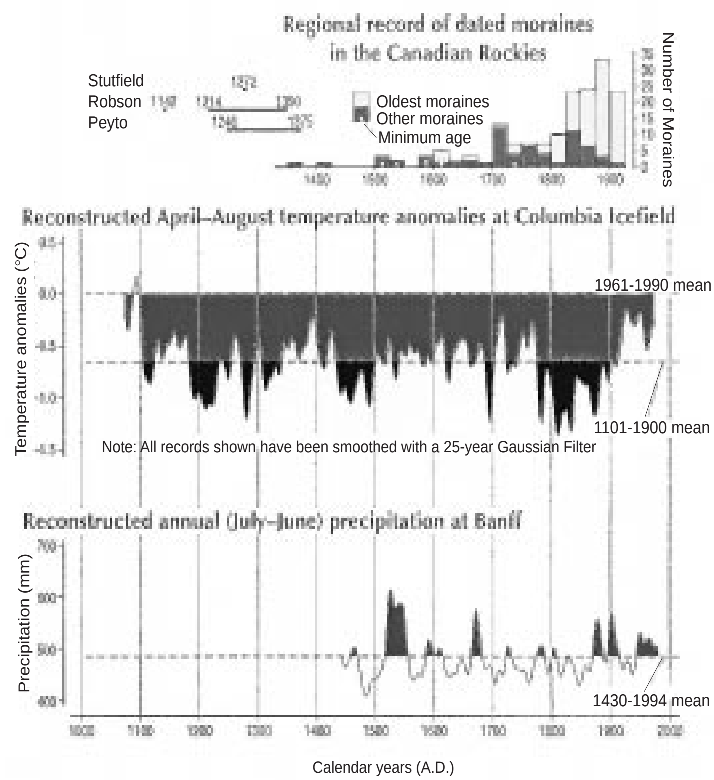

Figure 1. Proxy climate records developed from tree-ring studies in the Canadian Rockies. The upper diagram shows reconstructed summer temperatures from 1073-1983 based on ringwidth and maximum latewood density in Engleman spruce that grew near the Athabasca Glacier. Temperatures are deviations from the 1961-1990 mean (Luckman et al. 1997). The lower diagram shows annual precipitation from 1430-1994 reconstructed from ring widths of Douglas fir growing close to the hoodoos at Banff (Luckman and Watson 1999)

Subsequent measurement and dating of the tree samples in the laboratory at UWO revealed that this stand contains the oldest trees yet found in Banff National Park and the oldest whitebark pines in the Canadian Rockies. The two oldest trees, both cored at breast height, had earliest ring dates of 1015 and 1024 AD indicating ages of 984 and 979 years, respectively. Given the height at which they were cored, both trees are likely over 1000 years old. At the same site we cored another three trees that exceeded 800 years of age, 11

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Millennial-Aged Treees

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Table 1. Long tree-ring chronologies and oldest trees from the Canadian Rockies

COMMON NAME	SCIENTIFIC NAME	OLDEST SPECIMEN	LONGEST CHRONOLOGY RECORD[1]
Whitebark pine	*Pinus albicaulis*	>1060 Saskatchewan	950-1998 Saskatchewan[2]
Alpine larch	*Larix lyallii*	>838 Waterton	799-1993 Gray Creek Pass, BC
		>734 Banff Storm Mtn.	1152-1994 Larch Valley[3]
Limber pine	*Pinus flexilis*	>826 Kootenay Plains	732-1996 Kootenay Plains[4]
Engelmann spruce	*Picea engelmannii*	>761 Peyto	760-1990 Peyto[5]
Douglas fir	*Psuedotsuga menziesii*	>691 Banff	1306-1996 Banff[6]

Notes: [1]=longest abolute record; [2]=Youngblut 1999, with additions; [3]=M. Colenutt pers. comm. 1999 - the longest larch chronology from Banff National Park; [4]=R. Case pers. comm. 1999; [5]=Reynolds 1992; [6]=Watson 1998.

older than 600 years and 21 greater than 500 years. In 1999 we resampled the two oldest trees and a core from the base of the older tree yielded an innermost ring of 986 AD. However, this core missed the pith (centre) of the tree by a couple of centimeters and therefore the tree is probably between 20 and 40 years older than this. In addition, cores recovered from the tree shown in Figure 2 (not sampled in 1998), yielded an innermost measurable ring of 950 AD with a further ten countable rings and no indication of pith position. The minimum age of this tree is 1060 years, but as the oldest core was taken about 1.5 m from the base on the upslope side, and did not hit pith, this tree is probably 20 to 40 years older. These are the first trees from the Canadian Rockies with a documented age of greater than 1000 years and, according to our records, are the oldest trees in Alberta.

Table 1 summarises data on the oldest living trees and longest tree-ring chronologies we have developed for different species in Banff and Jasper National Parks. At several sites the chronology from living trees has been extended by matching ring sequences from living trees with the outer ring sequences from dead trees lying on the surface. The oldest tree previously sampled in Banff National Park was a 761 year-old Engelmann spruce growing near Peyto Glacier in 1991. The oldest previously sampled whitebark pine in the Rockies grew near Bennington Glacier (Mount Robson Provincial Park) and was 883 years old in 1986. However, both the Saskatchewan and Bennington pines are considerably younger than the oldest individual reported from the Sawtooth-Salmon Region of Idaho which was over 1270 years old. (Perkins and Swetnam, 1995). The pines near Saskatchewan Glacier are the oldest precisely-dated trees so far reported from the Canadian Rockies. Although 1000-year-old limber pines have twice independently been reported from the Whirlpool Point area further downstream along the North Saskatchewan River and outside the Parks (AFA, 1986; Case and MacDonald, 1999, pers comm), these ages are extrapolated from partial cores. The oldest tree reported by Case and MacDonald had 824 rings and a rotten centre. Several other long-lived species have also been found within Banff and Jasper National Parks, notably alpine larch at treeline and Douglas fir at lower elevations. The oldest larch we have found was an 822-year-old tree that died in Waterton Park in 1994 (The second oldest was 721 years old and sampled in Banff in 1990). At the lower treeline where moisture is important, the oldest Douglas Fir was sampled near Banff in 1997 and was 691 years old. This tree had previously been sampled and reported as 676 years old (AFA 1986). However Douglas fir are known to attain ages over 1300 years in coastal British Columbia. (Luckman and Innes 1991).

The tree-ring chronology developed from the whitebark stand near Saskatchewan Glacier (Youngblut, 1999) is the longest living tree chronology from a site in the Canadian Rockies. The growth patterns shown by this chronology are remarkably similar to those from long whitebark pine chronologies previously developed from living and snag material near Bennington Glacier (890 years) in Mount Robson Park, BC and from a site near Peyto Glacier in Banff Park (>1000 years). As these two sites are, respectively, approximately105 and 65 km from Saskatchewan Glacier, and in opposite directions, their coherent ring-width patterns suggest a regional control of growth which is almost certainly climate related. However, our studies to date indicate that this climate signal it is not as simple as that in other species we have studied in this region which show either summer temperature or precipitation controls. Sampling of additional whitebark pine sites and studies of the climate-growth relationship will be the primary goal of our continuing work on this species.

Brian Luckman is a Professor of Geography with the Department of Geography at the University of Western Ontario. He has worked in Jasper and Banff Parks for over 30 years on studies of environmental history, climate change, glacier fluctuations, snow avalanches and talus slopes.

Don Youngblut is a graduate student at the University of Western Ontario.

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Millennial-Aged Trees

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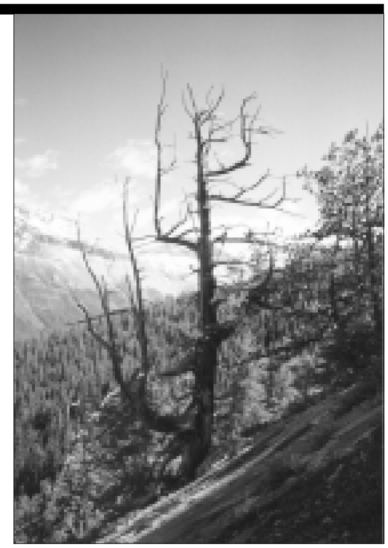

Photo: D. Youngblut, July, 1999

Figure 2.
The oldest living tree in Banff National Park. This whitebark pine is probably about 1100 years old. Foliage is restricted to the lower branches (just below the skyline) and the trunk has a strip-bark growth pattern (Living tissue only occurs on part of the circumference of the tree).

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Speaking of Avalanches

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Recoilless rifles (106 mm) were later added to the to the list of artillery used to trigger avalanches in the Pass. Evaluation and development of the system took place prior to the opening of the highway, as artillery control for highway use was unproven at the time. Many of the techniques developed during the initial years of highway design and operation are utilized today by the Avalanche Control Section in Glacier National Park. This unit is active each winter in the Rogers Pass, forecasting avalanche activity and working with the 1st Regiment, Royal Canadian Horse Artillery to control avalanches along the TCH through Glacier National Park. It remains the world's largest and most complex system of artillery use for highway avalanche control.

CURRENT RESEARCH

To obtain data for this oral history project, the author is interviewing and recording former and current staff of the Avalanche Control Section of GNP. In an informal setting, informants are asked key questions relating to their duties and experiences. The interviews are recorded to minidisc on a Sony CD recorder, and transcribed. Informants to date include Peter Schaerer, original engineer of many of the control features, and current avalanche forecasters. This research will synthesize information collected from a wide range of individuals, with a wide range of experiences, to assist in the creation of a database which records and reveals the personal experiences of the people who ensure the safety of the public travelling through the Rogers Pass each winter. Ultimately, the information gained from the oral-historical process will enable Parks to examine the evolution and current context of the Rogers Pass National Historic Site.

ACKNOWLEDGEMENTS

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Churchill Oral History Project

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Figure 4. HBC traders and local Inuit at Fort Churchill, c. 1910. (Courtesy of the Provincial Archives of Manitoba)

and their location north of the provincial boundary, have become distanced from the Churchill area where they once played an important role in the history of the HBC. Land claim disputes between the Inuit and other First Nations have further complicated the political climate in which historic site-related consultations must be carried out.

By providing input from an Inuit Elder concerning Inuit involvement with the Churchill area, this study contributes to a more balanced interpretation. It also underlines the need to move quickly to interview Aboriginal Elders who hold oral traditions concerning the history of many national historic sites. As we come to the close of the 20th century this knowledge is increasingly disappearing with the passing of the Elders.

ACKNOWLEDGEMENTS

Funded by Parks Canada, the Churchill Oral history Project was carried out by the Arviat Historical Society under the direction of manager David Ukutak, who also acted as translator. Cultural geographer Darren Keith and archaeologist Andrew Stewart were hired by the Arviat Historical Society to work with John Arnalukjuaq and David Ukutak as researchers and to report on the project's findings. Historian Robert Coutts of Parks Canada in Winnipeg was the Project Manager.

Interviews for the project were recorded on videotape, the originals of which are on file with the Arviat Historical Society. A final report on the project was completed in September of 1998 and has been summarized into a short, illustrated booklet in English, French and Inuktitut. Entitled Kuugjuaq: Inuit Memories of Life at Churchill, *the booklet will be offered for sale at the Parks Canada Visitor Reception Centre in Churchill and at other northern outlets.*

Darren Keith and Andrew Stewart are Meridian Geographic Consulting. Darren Keith is a geographer residing in Yellowknife who specializes in oral traditions research, heritage planning and geographic information systems.

Andrew Stewart, Ph.D. is a consulting archaeologist and research associate at the Royal Ontario Museum. For more information they can be reached at: dkeith@internorth.com.

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Using Satellite Imagery
for Forest Fragmentation Analysis

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of each time period. A second Hybrid Decision Tree Algorithm was used to classify the MSS image into the same habitat and disturbance units of the 1997 TM image.

Fieldwork was conducted in 1998 to: 1) collect information on forest stand parameters for structural classification; 2) record tree species, land cover type, and lichen cover data for caribou habitat suitability rating and mapping, and 3) verify the accuracy of the B.C. Ministry of Forests (BCMOF) forest inventory GIS database concerning species composition, and structural information (Deuling 1999). Approximately 300 plots in forest classes were identified through stratified random selection and sampled in the field for a structural complexity index. This index was used by Cohen and Spies (1992), and is a means with which to capture in a single stand attribute the variability found in several stand attributes.

Changes in forest age class distribution between 1975 and 1997 were mapped using the BCMOF forest inventory, with an interpolation routine to estimate the 1975 stand age of 1997 disturbance features based on the average age of surrounding forest stands. Spatial pattern metrics for comparing changes in habitat patches between time periods included: 1) class area, 2) number of patches, 3) mean patch size and SD, 4) patch density, 5) edge density and total edge density, 6) mean shape index, 7) mean nearest neighbor, 8) mean proximity index, and 9) mean core area (100 m edge distances). These were conducted for each habitat class for each time period, and for the old growth cedar/hemlock habitat class.

RESULTS AND DISCUSSION

Overall TM image classification map accuracy was 91.8%. A total of 557 pixel locations were checked, with the lowest user's accuracy at 83% in the Recent Disturbance (Unknown Agent) class. Errors were slightly higher in the MSS image with an overall classification map accuracy of 89.5%, caused in part by lower radiometric resolution. Using a knowledge-based classifying system, incorporating parametric classifiers with ancillary data sources dramatically increased map accuracy.

An analysis of changes in forest cover for all areas outside the national parks, from 1975 to 1997, showed a dramatic 150% increase in cut overs from 1975 to 1997, 1263 ha. (1.5%) to 3168 ha. (3.6%). The mature cedar/hemlock ecozone lost 11.1% of area, or 2489 ha., to cut overs. Forest burns and unknown disturbance classes decreased by 86% and 71% respectively, possibly due to increased fire control activities. Harvesting accounted for three-quarters of all changes in age classes.

The number of cut blocks increased from 1975 to 1997 by more than 500%, but mean size decreased by 58%, from 48.6 to 20.3 ha.; indicating a change in forest management policy to decrease the size of cut blocks, unfortunately increasing patches within the forest matrix. Predictably, edge density and total edge distance for cut blocks increased 254%. A disturbing result is a decrease of 31% in mean core area and 17% for core area proximity within the cedar/hemlock ecozone. Core areas are defined as forests more than 100 meters from an edge. Within the old growth forest of the cedar/hemlock there was a decrease in area of 10%, with more edges, less core area, and wider, more dispersed pattern for this class. The loss of core area in valley bottom forest habitat has major implications for many interior forest species. More research will be required to quantify the effects, particularly for representative species.

Predicting canopy structure using the TM wetness index was moderately successful (R = 0.586), significant to 0.01 level (Deuling, 1999). Old growth cedar/hemlock stands had higher wetness values (0 to 10) than spruce/fir climax stands (-11 to 0). Seral and late seral stands containing Douglas fir, western white pine, and aspen had TM wetness values that vary within the range of both cedar/hemlock and spruce/fir climax stands (-8.0 to 9.0). There is a strong relationship between TM Wetness and the Structural Complexity Index (R = 0.832); crown complexity increases with stand age (0.815), DBH (0.956) and lower stems/ha. (-0.673), all significant to 0.01 level.

Several questions will need answers if MRGNP can achieve ecological integrity in a managed forest system, including: What is the maximum disturbance level mountain caribou can accommodate sustainably? What actions should MRGNP, or any protected area, take if habitat loss is expected to exceed requirements for a minimum viable population?

The results of this research will be incorporated into a long term monitoring strategy for forest fragmentation.

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MEETINGS OF INTEREST

November 17-20, 1999

The Ecology and Management of Northwest Salmonids: Bull Trout II Conference. Canmore, AB This conference is a follow up to the Friends of the Bull Trout Conference, held in Calgary in May 1994. Bull Trout II will include approximately 40 presentations, by speakers from throughout the bull trout's international range. Topics will focus on the ecology and management of salmonids native to Nonwestern North America (bull trout, cutthroat trout, mountain whitefish, Arctic grayling and Dolly Varden). For presentation abstracts and registration information, check out the conference web site: http://www.cadvision.com/tuc/bulltrout2/index.htm

November 24-26, 1999

Globalisation, Ecology and Economy: Bridging Worlds. Tilburg, Netherlands. Organized by European Centre for Nature Conservation (ECNC), and GLOBUS - Institute for Globalisation and Sustainable Development of Tilburg University, in cooperation with The World Conservation Union (IUCN) and The World Business Council for Sustainable Development. Under the Auspices of Brabant-European Partnership for Sustainability. The follow up to the fourth Pan-European Ministerial Conference Environment for Europe (Aarhus, June 1998) as regards integrating economy and ecology, biodiversity. Builds on the outcome of the 1997 Basel Conference, Nature for East and West, organised by the Swiss Federal Office for Environment, Forest and Landscape. The Basel Declaration underlined the opportunities to harmonize the relationship between investment, development and nature conservation. Contact: ECNC, PO Box 1352, 5004 BJ Tilburg, The Netherlands. Fax: +31-13-466-3250; e-mail: gee@ecnc.nl; website: http://www.ecnc.nl

May 14-19, 2000

"Learning From the Past, Looking to the Future" The Fourth International Conference on Science and Management of Protected Areas (SAMPA IV). University of Waterloo, ON. SAMPA IV is co-sponsored by The Parks Research Forum of Ontario (PRFO), with co-operation from the UofW Heritage Resources Centre. SAMPA IV offers international speakers, presentations and posters on contemporary issues, and educational field trips to parks and protected areas in S. Ontario, including the Niagara Escarpment Biosphere Reserve and Point Pelee National Park. SAMPA IV has two major themes: Regional Approaches to Planning and Research on Protected Areas and Marine Protected Areas. Other topics include: ecological integrity, human dimensions, using science and research in decision-making, the impacts of globalization on protected areas management and approaches to education, interpretation and community outreach. For information: Tel: (519) 622-9362; e-mail: sampa.prioritygrow.on.ca or web site: http://landscape.acadiau.ca/sampaa

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. The goal is to achieve a better understanding of current and emerging environmental issues related to rights-of-way management by sharing environmental research and practical experience throughout the world. 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

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

http://parkscanada.pch.gc.ca

under Library in the Download Documents section.