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Research Links

A Forum for Natural, Cultural and Social Studies

Understanding Changes in Pacific Salmon

and the implications of climate change on ecosystem structure and function

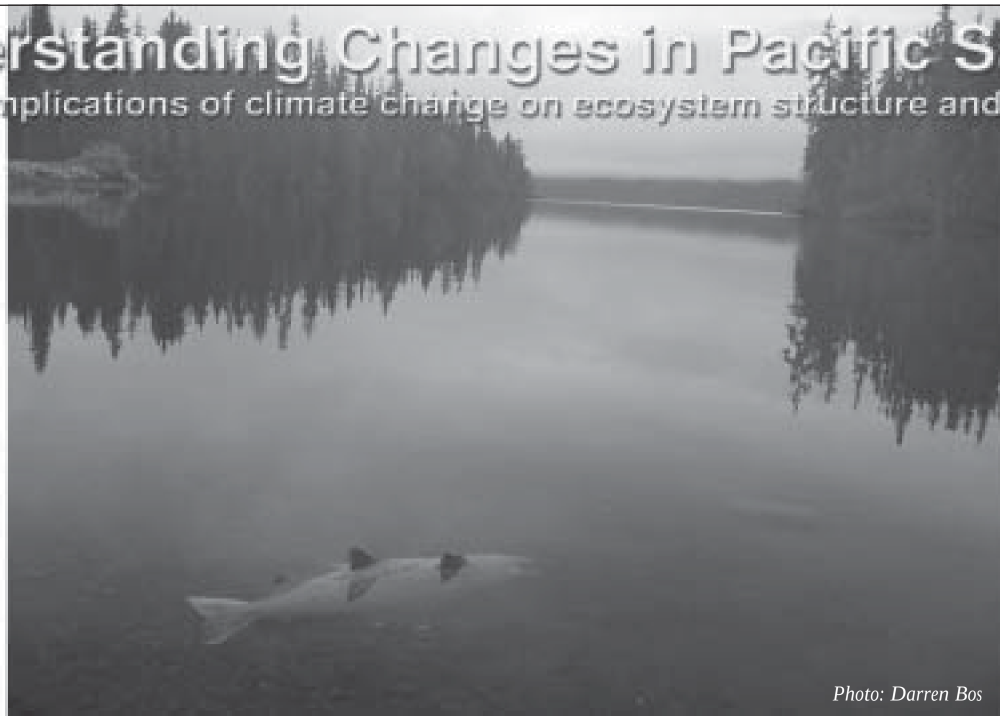

Photo: Darren Bos

Darren G. Bos, Marlow Pellatt and Bruce Finney

Pacific Salmon *(Oncorhynchus sp.)* play an integral role in many West-Coast ecosystems. The migratory nature of salmon causes them to interact with marine, fresh-water and terrestrial ecosystems. Across this range of habitats salmon are often cornerstones of food webs. In particular, spawning salmon are a valuable nutrient source that maintains productivity for many freshwater ecosystems (Mathisen *et al.* 1988, Kline *et al*. 1993). Salmon also provide a valuable source of energy and protein for many terrestrial vertebrates, among which bears are often a major consumer (Reimchen 1994). More recent research has shown that salmon may also directly enrich some terrestrial ecosystems when carcasses that have been removed from streams by predators are abandoned or from the excrement of animals that feed on salmon (reviewed in Cederholm *et al.* 1999).

Over the past century, the overall abundance of salmon has steadily decreased (Pacific Fisheries Resource Conservation Council 2001). Losses of habitat, fishing and climate change have all been implicated in this decline. Superimposed on these fairly recent decreases in salmon abundance are natural century and decadal cycles in salmon abundance. These cycles are now commonly referred to as regime shifts in which salmon productivity may rapidly change (within a year). In the context of global warming, the changes seen in previous regime shifts foreshadow the potential for loss of regional fish stocks, as was seen in the Washington Coho and Chinook stocks following a regime shift in the late 1980's (Beamish *et al.* 2000), or even ocean-wide northward displacement of salmon stocks accompanying the northward migration of temperature isotherms (Welch *et al.* 1998). Such a displacement could lead to the reduction or loss of Salmon throughout much of British Columbia, restricting salmon to cooler waters that would only be found in the Bering Sea.

Ecosystems that lose salmon do not simply lose one species, but suffer widespread changes as other species that depend on salmon disappear or are greatly reduced in

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UPCOMING DEADLINES

Research Links is a publication that highlights research from the natural, cultural and social sciences, and is published by the Western Canada Service Centre (Calgary).

Deadlines for submissions to future issues are:

APRIL 2, 2004

JULY 30, 2004

FRANCOPHONES

Le texte de cette publication est offert en français. Vous pouvez l'obtenir en écrivant à l'adresse à la page 24.

RESEARCH LINKS ONLINE

Previous issues of *Research Links* are available in PDF format from the National Library of Canada: http://collection.nlc-blnc.ca, on the WCSC Intranet, or by contacting us at: Research.Links@pc.gc.ca

Editorial

The subtitle for *Research Links* states "A Forum for Natural, Cultural and Social Studies" and this issue contains articles from *all* three disciplines. Bos' *et al*. article on the implications of climate change on ecosystem structure and function is particularly timely given Parks Canada's recent release of climate change scenarios and models for all National Parks[1]. Also within this issue, Watters presents the results of her MSc thesis in Jasper National Park, which demonstrates the difficulties associated with linking vegetation change to ungulate distribution. Using new GIS technology to uncover old cultural resources has allowed Perry to discover the location of Siding 29 in Banff National Park. And, Sparkes introduces us to social capital – a concept that simultaneously simplifies and adds even more complexity to ecosystem-based management. Her research provides clear direction for managers to improve social capital in Field Units.

My role in the Service Centre provides me with the privileged vantage to realize the diversity of research being conducted by Parks Canada. In contrast, discussions with Field Unit staff show me that Field Units are often so involved with local issues, that the breadth of research being conducted under the auspices of ecosystem management in western Canada can be unknown, and overwhelming. Parks Canada staff should be proud of this research diversity during the uncertain times of sustainable business planning, resource conservation re-structuring, limited funding and other government change.

The deployment of Ecological Integrity (EI) funds is a much-anticipated change for Parks Canada. Although the announcement to submit EI priority-theme proposals met with some consternation, the resulting projects will provide unique opportunities to demonstrate Parks Canada's commitment to Ecological Integrity. As EI funds are awarded, Parks Canada will be scrutinized, and most certainly evaluated on our ability to effect measurable change. I suspect all projects that receive EI funding will have strong communication and reporting components, and *Research Links* is well-established vehicle for sharing EI achievements with a broad audience. Although EI progress will be reported in State of the Protected Area (SOPA) and State of Protected Heritage Area (SOPHA) reports, *Research Links* may be a more detailed and meaningful way to communicate results within and beyond Parks Canada staff. I encourage EI practitioners to take advantage of the opportunity offered by *Research Links*, and I look forward to submissions relating specifically to how Parks Canada addresses EI.

Salman Rasheed
Ecosystem Conservation Specialist, Parks Canada WCSC, Calgary
and Editor of Research Links

[1]Scott, DJ. 2003. Climate Change and Canada's National Park System: scenarios and impacts. Parks Canada Ecosystem Science Review Reports

Noteworthy Item...

ANNUAL REPORT
of Research and Monitoring in National Parks of the Western Arctic

The Annual Report of Research and Monitoring in National Parks of the Western Arctic is a major effort by the Western Arctic Field Unit, and those we work with, to describe the ecological and cultural research and monitoring activities that are conducted in the parks each year.

These reports are provided to our partners, including Inuvialuit and Gwich'in organizations, co-management boards, other government departments, universities, the public and other Parks Canada staff.

The Western Arctic Field Unit has produced annual reports of research and monitoring since 2000. These reports provide basic information about each research and monitoring activity, such as the objectives, methods and initial results. Contact information is provided for those who require more technical detail.

This report is available in French and English from the Western Arctic Field Unit, Inuvik, Northwest Territories. PDF versions of the report can be downloaded from www.emannorth.ca/reports.cfm. Look for the report under the "EMAN-North Partners' Reports" section of the web site.

For more information about the Annual Report of Research and Monitoring in National Parks of the Western Arctic, please contact Ian McDonald. Tel: (867) 777-8807; ian.mcdonald@pc.gc.ca

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number (e.g., Hansen 1987, Miller *et al*. 1997, Hilderbrand *et al*. 1999, Gende and Willson 2001). While various efforts have been made to supplement nutrients artificially in systems in which salmon have already been lost or greatly reduced, there is growing evidence that artificial nutrient enrichment can only fulfil a small part of the role that salmon now play. Loss of salmon from rivers, streams and lakes within parks, and the larger ecosystem, would significantly change these ecosystems. While it may not be possible to arrest the climate change that is currently underway, it is important to understand how this change is likely to affect salmon so that management strategies can be developed to mitigate the loss of salmon and their dependant species.

Photo: Darren Bos

While there is good evidence that warmer temperatures could adversely affect salmon abundance, the current warming is unprecedented in the historical record. Given the widespread changes that take place within the ocean during regime shifts, extrapolating from the limited conditions during which we have observed salmon stocks to a new state is fraught with potential error. Instead, examining the distribution of salmon in the distant past (approximately 9000 to 6000 years ago) when conditions were four to five degrees Celsius warmer than present (which is comparable to most global warming scenarios) provides an opportunity to look at how future climate change will likely affect salmon.

Pioneering research by Finney *et al.* (2000) in Karluk Lake, Alaska indicates that the stable isotope ^{15}N found in lake sediments is a useful proxy of marine derived nutrients delivered to freshwater ecosystems by spawning salmon. Salmon accumulate most of their biomass at sea, which is enriched with ^{15}N relative to terrestrial and freshwater environments. When salmon die after spawning almost all of this nitrogen is released into the ecosystem through direct consumption of the salmon, or decay of the carcass and subsequent uptake by algae and bacteria. Thus, levels of ^{15}N in lake sediments deposited by spawning and dead salmon may be used as a proxy of the abundance of past salmon returns to a lake. Other indicators, such as algae and invertebrates, are also preserved in lake sediments and are also sensitive to the nutrients delivered by salmon.

One of the first hurdles to unravelling the past changes in salmon abundance is to find lakes that are good at archiving changes in salmon abundance. Lakes that have few salmon returning to them, or those that have intrinsically higher nutrient levels and thus benefit little from the nutrients of returning salmon, will not archive changes in past salmon abundance. The high flushing rate of many coastal lakes coupled with large catchments that may contribute nutrients to the lake means that many lakes in British Columbia may have poor records of salmon returns

METHODS

Lakes with historical records of sockeye salmon returns were selected across a spectrum of catchment and lake size found along the BC coast (Table 1). Sediment cores were extracted from each lake using a modified KB-type sediment corer with a diameter of 7.6 cm. Cores were taken from the profundal region of each lake in an area removed from steep slopes or stream inputs. Cores were sectioned at 0.25 cm intervals on the shore of the lake immediately after coring. Multiple cores were taken from Babine Lake because of its very large size and variety of sedimentary environments.

A minimum of three samples, each from a discrete 0.25 cm section, were taken from each core for C and N isotopic analyses. All cores had the topmost interval (representing sediment deposited in the last several years) analysed. Additional samples down core were taken to investigate historic ^{15}N levels. Samples for ^{15}N analyses were prepared by drying sediment for 24 hours at 80^{o} C. Crushed dry sediment was shipped to the University of Alaska for analyses using a Finnnigan Delta Plus mass spectrometer. Isotopic results are reported in δ notation:

$\delta^{15}N$ = (R sample/ R standard) – 1

Where R = $^{15}N/^{14}N$ and atmospheric N_2 is used for the $^{15}N/^{14}N$ standard.

Carbon and nitrogen percentages were measured by an elemental analyser interfaced to the mass spectrometer, and carbon

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Table 1. Morphometric and Sockeye Salmon escapement data for study lakes. Escapement data are averaged for the most recently available 10 years of data as of 2001.

Lake/Sample	*Max Depth (m)*	*Mean Depth (m)*	*Volume (10^6 m^3)*	*Surface Area (ha)*	*Catchment Area (ha)*	*Volume (10^9 l)*	*Flushing Rate (yr)*	*Sockeye Escapement (N)*	*Spawner Density (N/ha)*
Alice***	71.3	30.9	337.4	1092	47299	337.428	0.36	447	0.4
Antler***	34	5.3	1.1	20	552	1.06	0.07	NA	
Babine at Fulton ***	186	58.0	27368.3	47187	642010	27368.3	8.00	1327000	28.8
Babine at outlet***	186	58.0	27368.3	47187	642010	27368.3	8.00	1327000	28.8
Cheewhat*	21	9.0	12.2	135.7	1259	12.213	0.32	1362	8.8
Hobiton*	95	37.0	134.3	363	3987	134.31	0.91	7200	21.2
Kennedy* (Claquout arm)	130	62.6	1035.2	1653.9	13597	1035.25	2.30	4252	2.4
Kitwanga**	16.5	6.2	47.8	777	17914	47.7855	0.43	1400	0.5
Lakelse***	31.7	8.5	116.0	1365	39470	116.025	0.22	6000	3.7
Maggie**	42.5	22.0	51.9	236	5709	51.92	0.28	13	2.4
Meziadin***	120	45.0	1780.7	3957	67637	1780.65	1.43	228000	63.4
Morice***	236	100.0	9379.6	9379.6	184381	9379.6	2.57	14600	2.2
Muchalat***	63	38.0	203.3	535	21913	203.3	0.33	1213	4.3
Muriel**	45	22.0	35.7	162.15	956	35.673	1.13	1200	7.7
Nahwitti***	48.5	24.8	61.0	246	5088	61.008	0.31	2686	8.9
Sara***	35	12.6	5.8	46	797	5.796	0.37	NA	
Sproat***	195	70.0	2936.5	4195	35165	2936.5	4.37	163000	39.7
Yakoun **	91	34.7	284.9	820.9	7653	284.852	3.00	9400	8.0

* Lakes located within Pacific Rim National Park
** Lakes located adjacent to Pacific Rim and Gwaii Haanas National Parks
*** Lakes located within the greater park ecosystem
-Maximum depth for Maggie lake estimated from coring depth
-Mean depth for Maggie Lake estimated to be half of maximum depth (no bathymetry available)
-Mean and Maximum depth for Kennedy Lake from Rutherford *et al.* 1986
-Spawner density for Sproat, Muriel, Meziadin, Babine, Morice, Yakoun, Lakelse, Kitwanga, Hobiton, Long, Owikeno from Shortreed *et. al,* (2001)
-Spawner density for Alice, Muchalat, Nahwitti, Kennedy (Claquout arm), Maggie and Cheewhat extracted from NuSeds database (http://pisces.env.gov.bc.ca/)

to nitrogen ratios (C/N) calculated. We used the wide disparity in C/N ratios between terrestrial (~ 30:1 - 50:1) and aquatic systems (~ 5:1 - 12:1) to differentiate between aquatic and terrestrial sources of sedimentary material. (Hutchinson 1957, Elser *et al.* 2000).

RESULTS AND DISCUSSION

$\delta^{15}N$ data from these lakes shows that some have relatively high $\delta^{15}N$ levels and may be suitable for reconstructing changes in salmon abundance (Figure 1, page 6). Lakes that are more strongly influenced by their catchments (high C/N ratios) tend to have much lower $\delta^{15}N$ values. Seven of the seventeen lakes have their highest $\delta^{15}N$ values in the topmost sections of the sediment core. This observation may seem surprising, given that many salmon stocks along the coast are considered to be depressed as a result of commercial fishing, but may be due to enhancement efforts in these systems. Five of the seven lakes that have their highest levels of $\delta^{15}N$ near the top of the core have been enhanced with hatcheries, fertilized, or had barriers to salmon migration removed. Five lakes have their highest values in the lowest section of the core, which suggests decreases in salmon abundance. Four of these lakes have stocks that are documented to have collapsed during the last 20 years. The remaining five lakes lack a unidirectional change in $\delta^{15}N$ over the length of the core.

Five lakes (Meziadin, Kitwanga, Babine, Sproat and Kennedy) show good potential for being responsive to the nutrient inputs from spawning salmon. Their high ^{15}N values are consistent with nutrients from salmon being retained in the lakes, while their low and relatively constant C/N values suggests that the sedimentary nitrogen composition is not strongly controlled by their catchment. Other lakes, like Muriel, show somewhat lower $\delta^{15}N$ levels and higher levels of organic matter coming from outside of the lake. However, even here levels appear to be acceptable to allow interpretation with caution given to periods with high C/N levels that likely indicate periods of increased terrestrial influence.

Preliminary research from Muriel Lake demonstrates the effectiveness of this technique even in a relatively difficult environment and shows how it may be used in conjunction with other indicators to provide a more complete picture of past environmental changes (Figure 2, page 7). In Muriel Lake the record of $\delta^{15}N$ shows variable but relatively high historical values. However, at the top of the core $\delta^{15}N$ values plummet, which is consistent with a near total collapse of the salmon population in this lake. Algal indicators (diatoms)

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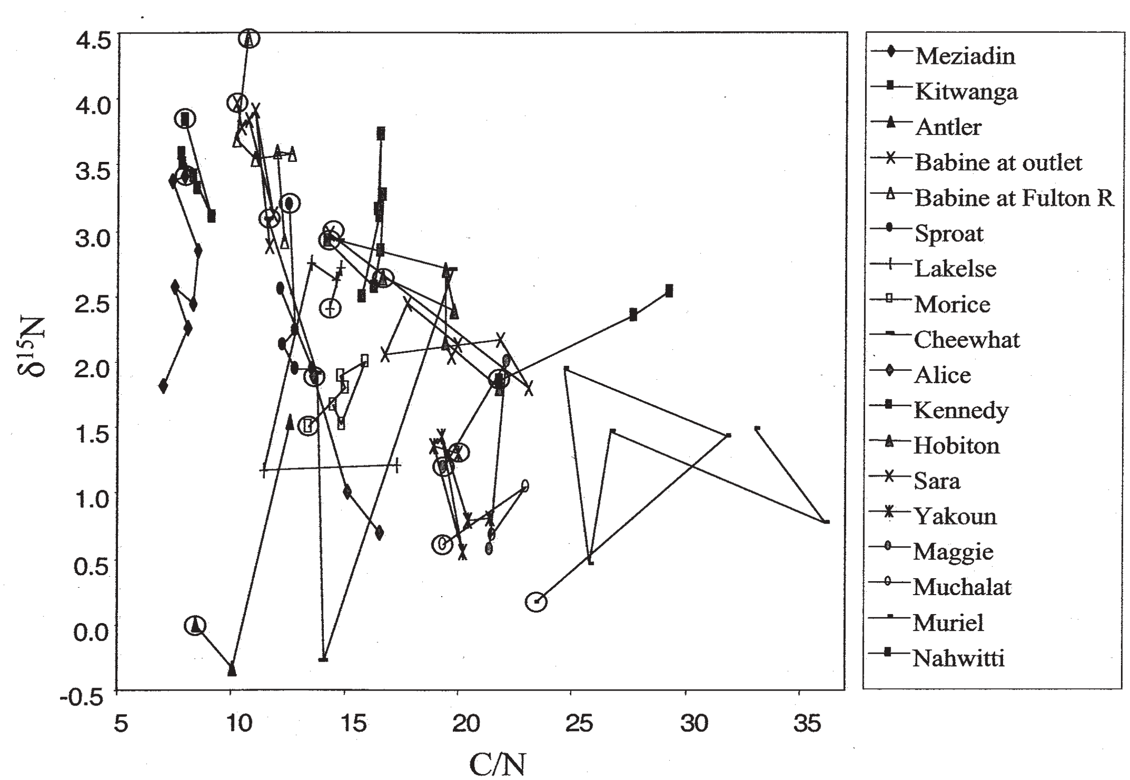

Figure 1. Sedimentary $\delta^{15}N$ from samples evenly spaced along the sediment core from each lake. The most recent sample (topmost) from each sediment core is denoted by a black open circle. The C/N ratio is used as a proxy of terrestrial input to the lake; higher C/N values represent greater amounts of terrestrial material in the lake sediment. The legend is ordered by increasing mean C/N ratio for the lake. Lakes with high C/N ratios tend to have greater variance (more horizontal dispersion) in their C/N ratio. This is consistent with the stochastic export (e.g., slope failures, extreme precipitation events) of terrestrial material into the lake being the cause of higher C/N ratios in the sediment.

that respond to nutrient levels in the lake corroborate this finding in that species such as *Aulacoseira distans* and *Tabellaria flocullosa* that are found when nutrient levels are higher in the lake. Similarly, with the recent decreases in $\delta^{15}N$ there is an increase in *Cyclotella* cf. *stelligera* which is a very small diatom that is more capable of utilizing nutrients at low concentrations.

CONCLUSIONS

Paleolimnological techniques, based on records found in lake sediments, can reconstruct changes in salmon abundance over long periods of time. This type of research can provide a context for the current changes we see in salmon abundance. Sediment cores that correspond to hundreds of years that are analysed at high resolution can provide a more accurate picture of the proposed cyclic changes in salmon abundance linked to El Nino and changes in the Aleutian low pressure system (approximately 40-year periodicity), while longer cores that span thousands of years could provide information on salmon abundance during periods in the past that were warmer than present and may provide a good analogue to future global-warming scenarios.

Currently we have identified several lakes in and adjacent to parks that should provide long-term records of salmon abundance in the region. However, not all lakes archive changes in salmon abundance equally well, and compromises will have to be made in

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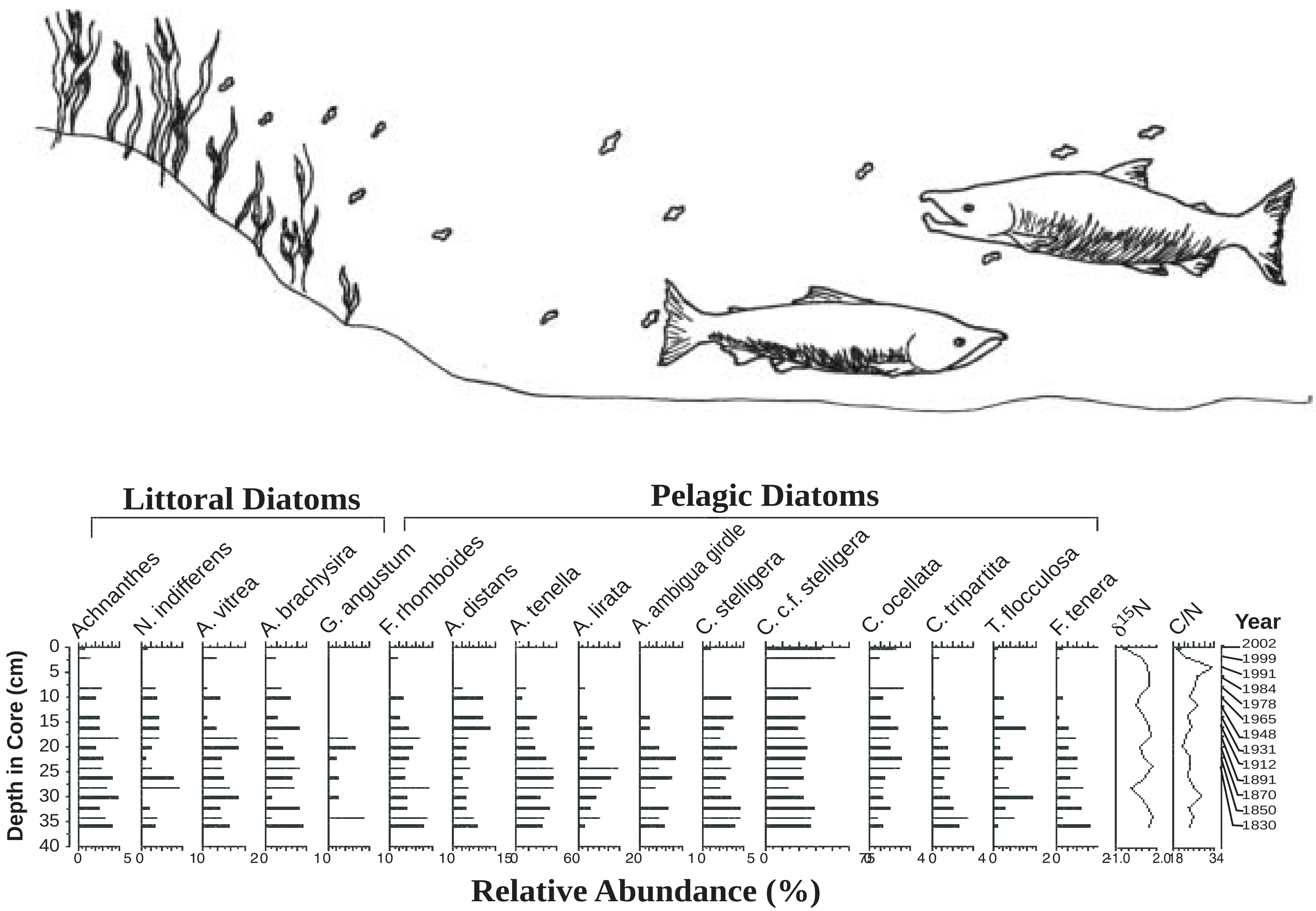

Figure 2. The paleolimonological record from Muriel Lake faithfully archived the relatively recent collapse of the salmon population in this lake. This is shown by the low $\delta^{15}N$ levels found near the top of the core, along with the disappearance of diatoms such as *Aulacoseira distans* and *Tabellaria flocculosa* that require higher nutrient levels and the increase in *Cyclotella cf. stelligera*, a diatom that is better adapted to lower nutrient levels.

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choosing lakes based on their proximity to areas of interest and their ability to record past changes in salmon. Our ongoing research will provide the first information on changes in salmon abundance on a regional level during a period of warming. It will have important implications for management of coastal ecosystems as well as providing data that will be valuable to managing one of the west coasts most valuable resources.

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Social Capital as a Dimension of Ecosystem-Based Management

This paper discusses social capital and suggests ways that social capital could enhance ecosystem-based management through understanding and drawing upon the civic networks in a landscape and the common beliefs that bond networks together.

Jennie Sparkes

WHAT IS SOCIAL CAPITAL?

Social capital is the supply of active connections between people including the trust, mutual understanding, shared values and behaviours that bind the members of human networks and communities together and makes cooperative action possible (Putnam 1995). Of interest to ecosystem managers would be social capital that contributes to strong, united stewardship ethics within communities or landscapes that lead to a more sustainable human relationship with nature. Within social capital different forms of capital can emerge (Figure 1). Bonding social capital refers to connections between like-minded people within the civic aspect of community, involves a high level of trust, and is exemplified by the "network of people we turn to when we are sick or need an important errand run" (Woolcock 2001a). An example of bonding social capital would be residents bonding together to address a common concern such as the survival of a local threatened species.

Networks can also serve as bridges between bonded groups within civic society. Bridging social capital refers to the people "who share broadly similar demographic characteristics" (Woolcock 2001a). This form of social capital is characterized by "building of connections between heterogeneous groups" (Schuller, Baron and Field, 2000). An example of bridging social capital would be resident from group "A" working with resident from group "B" to address their common concerns over the survival of a threatened species.

Networks may also be vertical and serve as links from civic society to institutions such as governments and academia. Linking social capital pertains to connections with people in power, whether they are in politically or financially influential positions (Woolcock, 2001a). The choice of groups "A" and "B" to engage government conservation officers in their quest to address their conservation concern would exemplify linking social capital.

As the word *capital* suggests within social capital, there is *value* in the connections that people hold. In social capital this *value* is the intrinsic value that these connections hold as a means of access to resources and collective social action. The *value* of social capital can be associated with the strength of its networks. A networks' strength can be the result of: 1) the density of connects within the network (Burt 1992), 2) the connections that exist to people of influence, or 3) the number of connections networks provide to new forms of knowledge a network holds (Adler and Kwon 2000).

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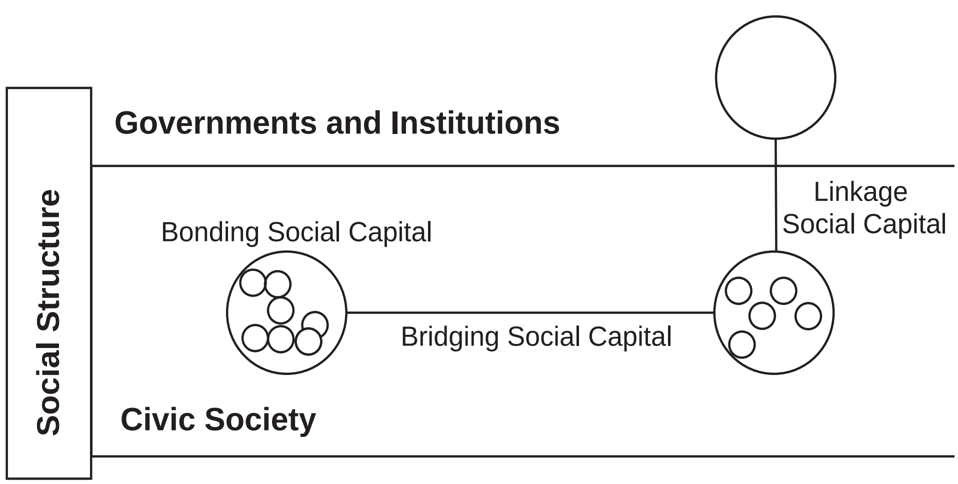

Figure 1. Different forms of social capital

For social networks to be built and sustained there must be shared trust, norms and beliefs. These dimensions of social capital are intertwined and can be both conditions for, and products of networks. The term *social cohesion* is frequently used to refer to the shared values, beliefs, trust, hope, and reciprocity dimension of social capital. Because of its cohesive nature, social capital has the capacity to facilitate cooperation through the establishment of networks based on mutually agreed to common rules, norms and sanctions.

SOCIAL CAPITAL AS A DIMENSION OF ECOSYSTEM BASED MANAGEMENT

Managing on an ecosystem scale is complex business. There are many forms of knowledge, interests and possible outcomes that must be considered. Social capital represent only one of many forms of information that can contribute to building a more holistic understanding of the factors at work within and upon an ecosystem. Beliefs, trust and norms that support and nurture social networks serve to regulate the flow of resources and energy between natural and social systems. The question becomes, how do ecosystem manager come to better understand the role of social capital as a practical dimension of ecosystem management? Three categories of possibilities emerge: 1) those related to ecosystem managers building social capital within communities; 2) those related to ecosystem mangers monitoring social capital within communities; and 3) those related to ecosystem managers diversifying the type of social capital they hold with communities.

1) Ecosystem Managers Building Social Capital within Communities.

This category is prefaced in the understanding that one of the emerging roles of government may be to become facilitators of social networks, beliefs and norms that contribute to sustainable human relationships with nature while at the same time accommodating democratic governance. This could include building capacities, such as knowledge and skills, in communities to evolve civic actions towards strong(er) stewardship ethics.

Examples of what building social capital may look like:

- Provide existing conservation-focused networks within communities with access to knowledge, skills, mentorship, and equipment as a means of assisting them to expand their networks and/or actualise their beliefs.
- Develop specific strategies for Parks Canada to participate in regional networks as an equal player in the ecosystem; and to work together to try and find common ground, particularly with those whose behaviours and beliefs seem to be contrary to desired ecological outcomes.
- Create new networks between government agencies not traditionally associated with resource conservation or management, such as health services, volunteer participation organizations, social justice, welfare economic, industrial practices/standards, education, religion, international development, to attain a better understanding of the integrity of the (whole) ecosystem/landscape.

2) Ecosystem Managers Monitoring Social Capital within Communities.

This category is prefaced by stating that monitoring is important to determine whether Parks Canada's efforts to participate in regional networks, and to build shared mental models and make decisions collectively are effective. Many ecosystem management efforts include education and outreach programs, how effective are these in changing core beliefs?

Examples of what monitoring social capital may look like:

- Structure community stewardship education and engagement efforts as social science research projects (e.g., action research) to determine the network channels that disseminated information took (breadth of distribution of information and knowledge) as well as identify any resulting changes in beliefs, trust and/or normative behaviour as a result of the educational or engagement exercise.
- Monitor the networks that import and export different types of goods and services into and out of communities to assist ecosystem managers in understanding the influence of the broader political, social and economic networks over-layered onto ecosystems. Gathering information on the trade networks can contribute to calculating the "ecological footprint"[1] of human beliefs and normative behaviours within an ecosystem.

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[1] Ecological Footprint is the land and water area that would be required to support a defined human population and material standards indefinitely (Wackernagel and Rees 1996, p 158).

3) Ecosystem Managers Diversifying the type Social Capital they hold within Communities.

The preface for this category is that social capital can bring people together and enable them to work toward a common purpose through mutually agreed upon values, such as common rules about how decisions are made, or goals like ecological integrity, or economic viability, or health. The more social capital that is available, the more collective planning and action that can happen. The more collective planning and action that happens, the greater our ability to practice EBM.

Examples of approaches to diversifying the type of social capital governments hold with communities may look like:

- Provide incentives for ecosystem managers/staff to become active volunteers within their communities on office time, e.g., one day a month, to create access to new networks of beliefs.
- Lead, by example, through respectful, open and regular interactions in communities through stewardship-focused lifestyles that contribute to both social and ecological well-being within their communities.

CONCLUSION

Social capital assists in understanding the capacity that exists in communities to move towards collective actions, including stewardship actions. For ecosystem managers, social capital provides insight into how social systems nested within ecological systems are structured and how these systems draw upon and impact natural resources to service their beliefs and normative behaviors. Grumbine (1994, 1997) identified ten dominant themes that emerged within the ecosystem-based management practices that he examined in the United States. Within these ten themes, Grumbine (1994, 1997) observed that effective ecosystem-based management was "based on interagency cooperation;" a cooperation amongst all parties at an interagency level to manage ecosystem problems. Similar to Grumbine's (1994, 1997) observation about the need for interagency cooperation, civic society must also learn to work in a collective and cooperative fashion to contribute to the integrity of ecosystems. This suggests that one of the emerging roles of ecosystem managers could be facilitating the building and monitoring of stewardship focused social capital within the landscapes they manage. In doing so it may also require that ecosystem managers begin to diversify the type the social capital they themselves hold with communities.

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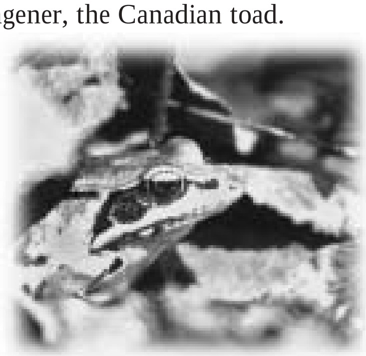
RESEARCH

TOADS IN TROUBLE

Elk Island National Park (EINP) is a remnant of native Aspen Parkland located in a landscape dominated by agriculture and rural residences. Although it is a protected area, in the last 20 years the Canadian toad (*Bufo hemiophrys*) has nearly disappeared in the park. The Canadian Toad was placed on the "Red List" in Alberta in 1996 because it's distribution in the parkland region had declined dramatically. During this same period the western toad or boreal toad (*B. boreas*) colonized EINP. Western toad is considered "a species of special concern" in Canada by COSEWIC and listed as "sensitive" in Alberta because it has suffered population declines and extirpations in the northwestern USA. Despite its apparent sensitivity to environmental change, the western toad is found in many ecoregions in Alberta, including the Rocky Mountains, boreal forest, and parkland. In fact, in parts of northern Alberta the western toad is actually expanding its range eastward possibly at the expense of its smaller congener, the Canadian toad.



Wood frog (*Rana sylvatica*)

Expanding upon previous work by MSc student Sara Eaves, we conducted surveys from May to August, 2003 to determine the current distribution of toads and other anurans in EINP. We conducted standardized visual surveys at 232 ponds in EINP and also 7 ponds on sandy grazing land just outside EINP. We walked slowly around the perimeter of each pond searching approximately 1 m to each side or in front for amphibians visible without moving debris. We attempted to capture all amphibians observed for identification and measurement.

Canadian toads were not observed or heard calling anywhere. Besides western toad, we encountered wood frogs (*Rana sylvatica*) and boreal chorus frogs (*Pseudacris triseriata*). Wood frogs were found at 223 ponds and chorus frogs at 199 ponds in EINP; both species were found at all 7 ponds on the sandy grazing site and were abundant at all sites. Western toads were common but much less abundant than wood and chorus frogs and patchily distributed in the Park. Western toads were found at 40 ponds in EINP and at all 7 ponds on the grazing site. We observed a total of 3026 wood frogs, 2633 chorus frogs, and 669 western toads throughout the summer.

Wood frogs and chorus frogs both appear to have healthy populations in and adjacent to the Park. The western toad was not historically present in EINP but has been expanding its range eastward. The western toad now appears to have well-established populations in some areas of the park. It is not known if western toad's current distribution is limited by habitat features or whether it will continue to expand its range in the Park. The last record of the Canadian toad in EINP was one calling male in 2002. Our surveys suggest the Canadian toad is now either extirpated or will be very soon.

In the future we plan to radio track western toads in EINP and also radio track both western and Canadian toads near Lac La Biche where both species co-exist. Western and Canadian toads grow large enough that adults can carry a back-pack type radio transmitter. Radio tracking will not only yield data on behavioural differences between ecoregions and between disturbed vs. undisturbed sites, but also important data on critical microhabitat features, movement corridors, home range size, and hibernation locations. We hope to use the western toad as a model for developing proactive conservation strategies for amphibian species that still have healthy populations in Alberta.

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HIGHLIGHTS

Parks Canada's Research and Collection Permit System Revamped

The present research and collection permit system was introduced in 1987. Over the intervening years, researchers expressed concern with the inconsistency with which parks across Canada implemented the system. Both the Panel on the Ecological Integrity of Canada's National Parks and participants at workshop held in 1994 at the University of Regina, concluded that the permit system needed revamping. For example, the Panel concluded that there was no predictability to the ground rules and procedures seemed to be different from park to park for no apparent reason.

A review was carried out of the strengths and weaknesses of the present permit system along with a review of a new on-line system introduced by the United States National Parks Service in 2001. This resulted in a major overhaul of our system to be implemented by February 2004 and an update of the guiding management bulletin.

The key feature of the new system is an Internet-based permit application. This will be supported by a comprehensive, on-line researcher information package. It includes a researcher's guide, listings of park research priorities, a list of park research coordinators, an on-line researcher reporting system, and an electronic feedback mechanism. For those staff in parks with the responsibility to administer the permit system, an on-line training tutorial has been developed. To inform the research community of these changes, communication materials have been developed and will be circulated widely to researchers, institutes, and other government agencies.

Parks Canada is focusing on building effective communications with researchers and sending the message that research is welcomed in parks; it is a vital part of park management; and nationally protected areas play an important role in resource management as well as scholarly research. While it is hoped that the introduction of the permit system will go smoothly, undoubtedly, some technical bugs will occur that will take time to correct. We plan to continuously improve the new system as we gain experience.

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ELK HERBIVORY IN JASPER NATIONAL PARK

Megan Watters, Evelyn Merrill and George Mercer

Jasper National Park has a long history of vegetation monitoring, starting in 1942 (Cowan 1942) in response to apparent deterioration of ungulate winter ranges with increasing elk populations (Figure1). The National Park Service established exclosures in 1942 at 6 sites throughout the Athabasca Valley, chosen on the basis of winter-use by ungulates, and were considered representative of winter ranges (Pfeiffer 1948, Banfield 1952, Flook 1955). Since the 1940s, a number of management actions have resulted in reduced elk numbers (Figure 1) and improved range condition (Trottier 1979), including an elk culling program in the 1970s. A new concern arose in Jasper in the late 1990s, when 250 habituated elk were year-round residents in high-human-use areas (HUA's), including the Jasper townsite, Jasper Park Lodge, and Whistler's campground, and were commonly seen in these areas during the summer (*pers. comm.* W. Bradford, JNP). In contrast, during the mid 1980's, only about 50 elk were year-round residents in the same area, and were not commonly seen in HUA's during the summer. By the mid to late 1990s, the increasing occurance of elk-human interactions, along with concerns that elk may be having a severe impact on grassland vegetation (*pers. comm.* W. Bradford, JNP), prompted the translocation of 220 elk from HUA's in 1999 and 2000, to the western edge of Jasper NP (JNP 2000). Some of the translocated elk returned to the town area (*pers. comm*. G. Mercer, JNP), and it was unclear in 2001 and 2002 whether elk use was still greater closer to the town, and what effect this and past utilization has on grassland vegetation.

The purpose of our research was to determine whether ungulate use was greater closer to town, despite removal of 220 elk in 1999 and 2000, and how vegetation cover and species richness differed inside and outside the ungulate-proof exclosures, relative to distance from town. To do this, we conducted intensive vegetation surveys at 8 of the12 exclosure sites, ranging between 2 and 30 km from town. We hypothesized that ungulate use, including elk and sheep, would be greater closer to town, and that this heavy use should result in a greater difference between fenced and grazed vegetation close to the town compared to sites further away.

Figure 1. Elk population trends in Jasper National Park, Alberta (1880's – 2000).

METHODS

We tested the hypothesis that grasslands close to town received greater elk and sheep use than those further away by regressing the number of pellet groups to distance from the centre of the townsite. We conducted ungulate pellet group counts in August 2001 at 70 accessible, low elevation grassland sites. We used 1 2-m x 30-m long transect per location and counted the number of pellet groups within each transect.

In July 2002, we conducted vegetation surveys at 8 of the 12 montane grassland sites, where each site had 4 permanently marked transects (8 m long, 2 m apart) inside and outside an exclosure. We used the Canopy Coverage Method of Vegetation Analysis (Wroe *et al.* 1988; Robertson & Adams 1990) to collect data from a total of 32 Daubenmire frames (0.1 m^2) within each exclosure and another 32 frames outside. In each frame, we estimated the percent canopy cover of graminoids and forbs, as well as species richness, defined as the average number of species per daubenmire frame. We calculated the difference in average vegetation cover and species richness in fenced and grazed grassland, and used a Spearman Rank Correlation (a=0.10) to test for relationships between distance from the townsite and difference in fenced and grazed vegetation cover and species richness.

RESULTS

The average elk pellet group density was 0.36 pellets/m^2, while the average sheep pellet group density was 0.04 pellets/m^2. We found a negative relationship between elk pellet group density and distance from the townsite (r^2=-0.25, P<0.05; Figure 2), while sheep pellet group density had a positive relationship with distance from Jasper townsite (r^2=0.23, P<0.10; Figure 2). We failed to find, however, any relationship between distance from the townsite and difference in fenced and grazed graminoids and forbs (Figure 3), or species richness (Figure 4).

DISCUSSION

As we hypothesised, elk use was greater closer to the townsite, confirming that elk are being attracted to high-human-use areas, despite the removal of 220 elk in 1999 and 2000. Interestingly, all surveyed areas within ~7 km of the townsite had pellet group densities > 0, indicating that most available grassland is used close to town. There are several reasons that elk may be attracted to high-use areas, such as Jasper Park Lodge, the townsite, and Whistler's campground (*pers. comm.* W. Bradford, JNP). First, the townsite act as a predator refuge, as wolves (*Canis lupus*), one of the primary predators tend to avoid HUA's and busy roads (Dekker *et al.* 1993). Second, elk readily use the lush green lawns and shrubs carefully maintained by town officials and homeowners (JNP 2000), as these are more easily accessible than the high elevation summer ranges. The combination of a readily available food supply and lack of access by predators makes Jasper townsite and the immediate surrounding grasslands a strong attractant for elk.

There is concern that grasslands near the townsite may be unable to sustain the present heavy levels of use, and that vegetation diversity and productivity have been adversely affected by high elk concentrations (JNP 2000). At high grazing intensities, such as year-round grazing, both above- and below-ground production tends to decrease (Holland and Detling 1990, Willms *et al.* 2002), and species richness may be reduced (Milchunas and Lauenroth 1993). We hypothesised that if grassland use were greater closer to the town, there should be a negative relationship between distance to town and the difference between fenced and grazed vegetation. For example, the difference between fenced and grazed graminoid cover should be greater closer to town than at more remote sites, given that use is greater close to town. However, neither graminoid nor forb cover

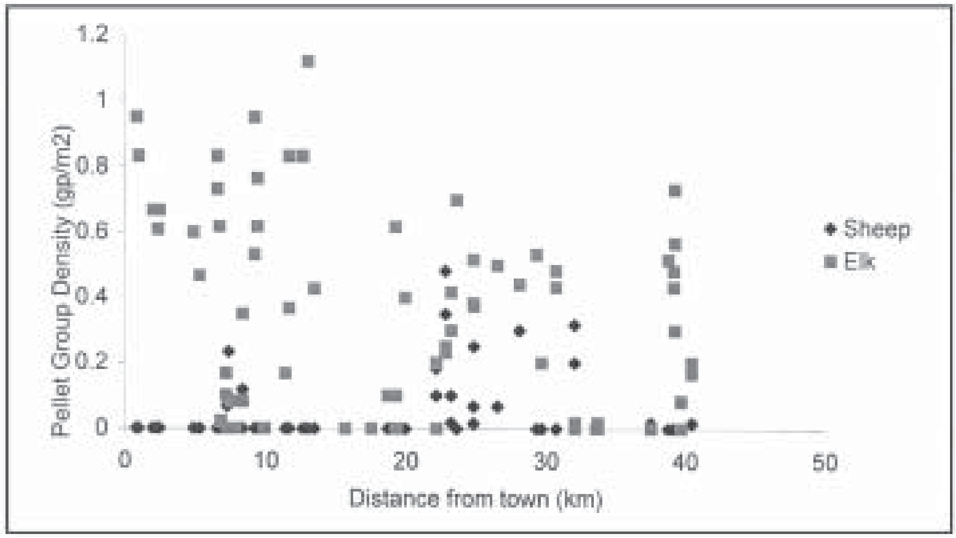

Figure 2. Relationship between ungulate pellet group density, measured in August 2001 from 70 grassland locations throughout Jasper National Park, and distance from the townsite of Jasper, Alberta for elk (r^2= -0.25, P<0.05, n=70) and sheep (r^2= 0.23, P<0.10, n=70)

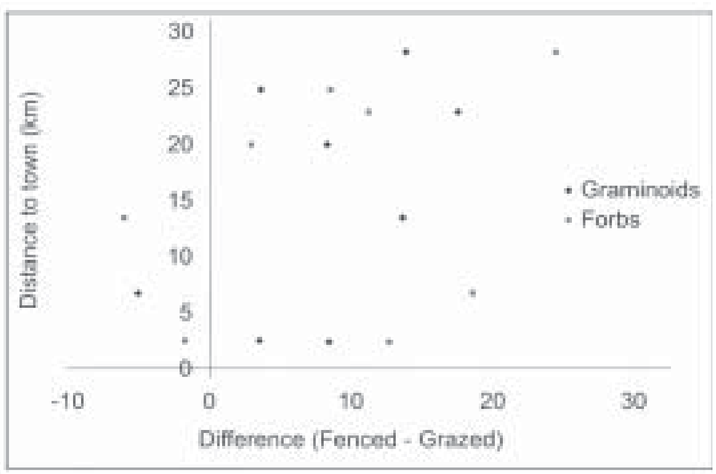

Figure 3. Relationship between distance from Jasper townsite (km) and difference between fenced and grazed graminoids (r^2= 0.24, P>0.10, n=8), and forbs (r^2= 0.40, P>0.10, n=8).

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was negatively related to distance to town (Figure 3), suggesting that although use is greater closer to town, elk are not having a greater effect on production. Likewise, the difference in species richness inside and outside exclosures was not significantly related to distance to town (Figure 4), implying that heavier grazing does not affect a measure of diversity. The lack of relationship between distance to town and grazing effects may be related to the fact that although elk grazing decreased further from town, sheep grazing increased, perhaps resulting in equally high grazing intensity throughout the landscape. Alternatively, small sample size and different grazing histories at the 8 sites may have obscured a pattern, although, unfortunately, there were few records of the grazing histories of these sites.

CONCLUSIONS AND MANAGEMENT SUGGESTIONS

Although grassland use, indicated by elk pellet group counts, had a negative relationship with distance from the townsite, vegetation did not appear to be affected by this greater intensity of use by elk. Translocation of elk may have reduced the risk of elk-human conflict, elk apear to stil be concentrated in high-human-use areas close to town. Because sheep are important herbivores further from town, park managers need to consider all ungulates, including elk and sheep, in their grassland management projects.

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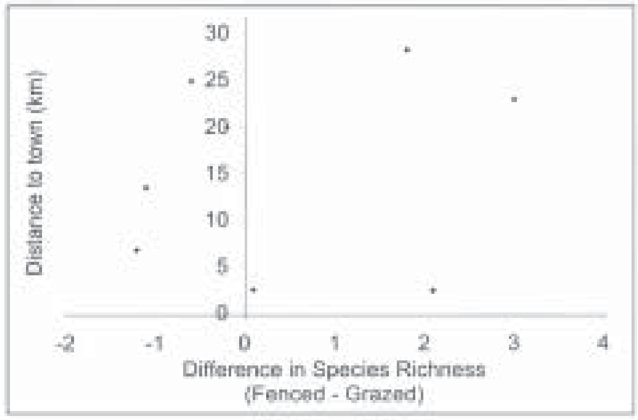

Figure 4. Relationship between distance from the townsite (km) and difference between fenced and grazed species richness at 8 grassland sites in Jasper, Alberta (r^2= 0.07, P>0.10, n=8).

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Using Archival Maps in a High-Tech World

Bill Perry

Siding 29 was the first railway station at Banff townsite. Constructed as the twenty-ninth siding west of Medicine Hat within the CPR's Mountain Division of the Transcontinental railway, Siding 29 was located near Cascade Mountain, following the new rail route from Calgary. Following the laying of the siding track on October 27th, 1883, a few tents and rough shacks soon sprang up nearby, including a section house and a small station constructed by railway crews to service the fledgling Banff community. One year after the construction of a small station building, Siding 29 was abandoned in 1889 for a location closer to the new Banff community some 2.4 kilometres to the west. Over 100 years later, archaeologists and historians have looked for the original siding without success until advances in computer mapping technologies coupled with the fortuitous discovery of several historic maps and photographs have brought to light the location of this historic siding.

BACKGROUND

Since the early 1980s, several attempts have been made at finding the location of the abandoned siding and related historic features. The focus of archaeologists has been the former Buffalo Paddock/ airfield area, as this was identified in a 1984 archaeological survey (Wilson 1985) as possessing a site with dateable ceramics and bottles from this time period. Until very recently, plans were made to investigate one of these sites as a potential Siding 29 location (site 558R; Langemann 1999). The area has been highly changed over time with impacts such as townsite development, past use as a animal paddock area, use of the area as an airstrip, construction and widening of the TransCanada highway, and railway construction and maintenance activities — all leaving their mark on the landscape. Considering the scant physical traces the siding buildings would have left behind; the challenge became how do we reconcile 120-year-old maps against such an extensively changed modern landscape?

In 2000, an archaeological/historical inventory (Langemann & Perry, *in preparation*) of the entire rail line route within Banff and Yoho national parks was implemented to compliment an earlier railway study in Glacier National Park conducted in the late 1980s (Sumpter & Perry 1988). The Glacier National Park inventory documented the location and state of preservation of remaining railway-related historic features and made recommendations for their preservation and management. During the 2000 survey,we discovered two linear historic features within the area of interest: one, a remnant of a historic access road and associated bridge remains (site 2071R); the other, what was surmised to be spur line remnants located on the north and south sides of the existing tracks in this area (site 2072R)(Figure 1). A simultaneous discovery of four historic maps (an 1886 CPR track plan; and 1887, 1888 and 1890 topographic maps) and one historic photograph (Figure 2) began to set the stage for new thinking on the location of Siding 29.

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Figure 1. Circa 1885 photograph showing Siding 29 (Canadian Pacific Archives A4192).

METHODS

Historical Analysis

During the 2000 railway survey, Gwyn Langemann and I discovered an historic access road and associated bridge remains spanning a minor drainage (site 2071R; Figure 2); and discontinuous spur line remnants on the north and south sides of the existing tracks for a distance of 1.5 km in this area (site 2072R; Figure 1). The historic road grade gave access from Banff Avenue to the old buffalo compound caretaker's cottage located immediately north of the CPR mainline (site 1954R; Figure 1). This road dates from the days when the area was part of a large buffalo compound and later used as a Warden station (Langemann 2001). Evidence of the buffalo compound use of this area can be seen in numerous wire-filled pits scattered throughout the area from removal of the compound fencing (site 93R; Figure 1). Curiously, the access road grade takes a 150 metre jog eastward just south of the railway for no apparent reason. The length of the spur line remnats associated with site 2072R (1.5 km) may indicate an association with the later historic Bankhead station and siding and not related to Siding 29.

We discovered a circa 1885 photograph of Siding 29 which showed a steam locomotive, a frame construction section house, a privy, and a small building across from the section house between the siding tracks and the mainline (Figure 2). The photographer appears to be standing on the siding grade looking northeast towards Cascade Mountain in the background. The four historic maps we discovered while doing background research for the railway survey included an 1886 CPR track plan, as well as 1887, 1888 and 1890 topographic maps. The first map showed the CPR rail grade through the Banff area and dates from circa 1886. This map shows the Siding 29 siding grade adjacent and south of the present rail grade; and showed the section house on the north side of the rail grade towards the current Trans-Canada Highway. In addition, the location of an engine house and water tank was noted approximately 800 metres to the west. A second map, an 1887 topographic map shows the old access road from Banff Avenue and a plotted location for the Siding 29 station. An 1888 topographic map shows the same access road connecting to a trail network south of the tracks, then veering 180 m eastward, crossing the railway to link up with a northerly trail. This is also mirrored in an 1890 topographic map.

GIS Analysis

The Cultural Resource Services of Parks Canada Agency in Calgary have long used geographical information systems (GIS) to analyze and map archaeological information. The latest generation of GIS analysis and mapping tools allows you to easily scan, georeference and overlay maps. In this case, four historic maps were overlain on a high-resolution photomosaic of the Banff townsite area. By making the historic map layer partly transparent, the user can see through it to the modern photomosaic below. In this way, one or several layers can be overlain to determine the location of historic features on the modern landscape.

The 1885 historic photograph clearly shows the presence of at least three buildings and a siding grade in the study area. The three structures and the siding grade should have left archaeological remains. Other structures including shacks and tents may have left less lasting archaeological evidence. The challenge was to determine their geographic position on the modern landscape. Using a GIS, all four historic maps were overlain on the modern photomosaic landscape. When the circa 1886 CPR track plan was overlaid, a 525 metre stretch of siding grade was noted starting just west of the current access road to the Banff industrial area. The location of the section house and engine house/water tank was also outlined.

The original Siding 29 station was located on the 1887 topographic map approximately 200 m east of the old access road when overlain on the modern photomosaic. As well, the 1888 and 1890 topographic maps when overlain on the modern photomosaic showed the trail at the north end of the old access road veering off to the east before it crossed the rail grade at the original station location – even though the station had been moved by this time.

Although a large portion of the discontinuous siding grade originally recorded during the 2000 railway survey (site 2072R) coincides with the mapped location of Siding 29 siding (Figure 1). What is assumed to be some kind of access grade to the old section house on the north side likewise was also originally recorded in 2000 as part of site 2072R, the proposed Bankhead siding. What was originally recorded in 2000 and given the site number 2072R, can now be reworked as part of the new site of Siding 29. The access road and associated bridge remains (site 2071R) that were also recorded in 2000 that show up in both the 1888 and 1890 topographic maps, can be left as a separate site as they likely serviced both Siding 29 and later animal paddock era structures.

Ground Truthing

Beyond the initial discovery of the surface historic features discovered in 2000, the area had received little attention. After the GIS and historic analysis of the archival maps and photograph, we decided to ground truth the study site.

We confirmed the location of Siding 29 during a second site reconnaissance trip. The overlay of the 1886 CPR track plan fit

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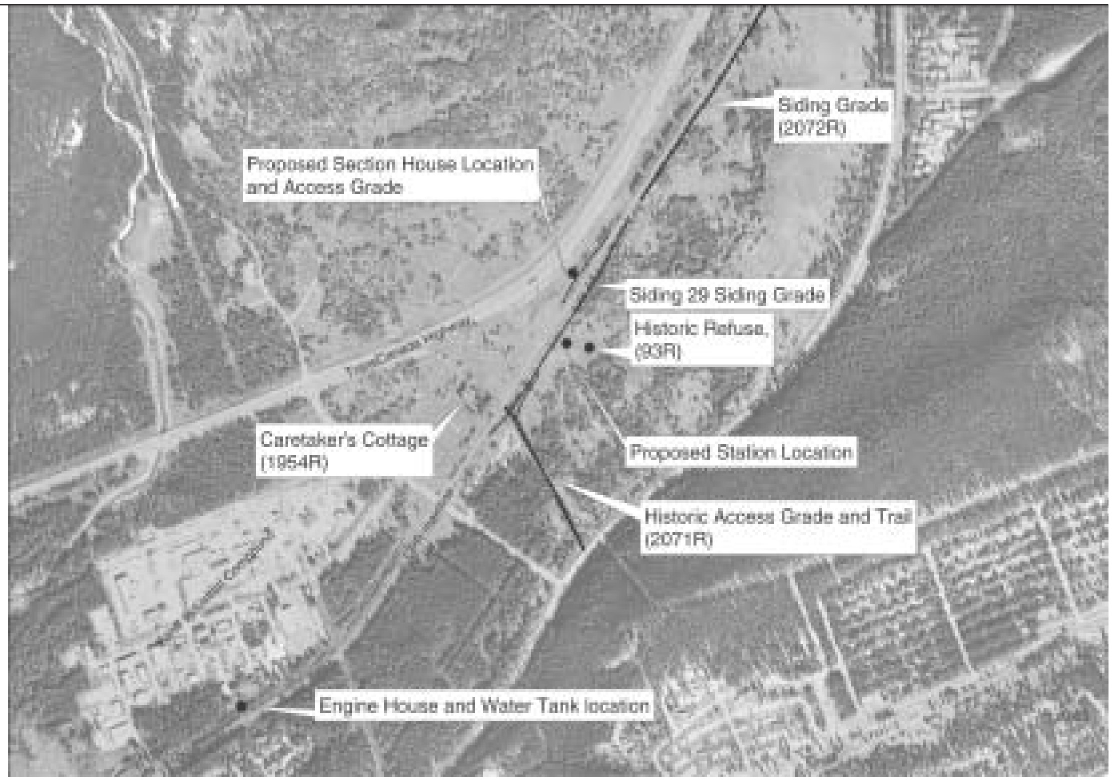

Figure 2 Location of archaeological features, Siding 29, sites 2071R and 2072R, Banff National Park.

perfectly with on-the-ground observations. The actual siding was located in the field and measured approximately 540 m long, 10 m south of the existing track. The vehicle track which led off the old access road from Banff Avenue intersected the siding grade approximately 100 m east of its junction with the current rail grade (Figure 1). This odd little jog is the same one noted on the 1888 and 1890 topographic maps which likely serviced Siding 29. The jog in the road was preserved even after the station was removed and the siding abandoned.

We were unable to find the old section house, however. An 183 m long east-west road grade was found to parallel a deep ditch on the north side of the track approximately 250 m east of the old Banff Avenue access road, was all that remained. The area to the north and west of this feature had been extensively impacted by past borrow source activities connected with the TransCanada Highway construction. It is in this impacted area that the section house and road grade were located (Figure 1).

An engine house and water tank noted on the original 1886 CPR track plan were located some 800m to the west of the main group of siding features, immediately north of the rail grade. A large cleared platform was found, measuring 15 m east-west by approximately 30 m north-south, where it merges with modern industrial yards (Figure 1). This earthen platform is level with the rail grade and sits approximately 2 m above the surrounding low-lying natural terrain.

On the 1887 topographic map and indirectly shown on the 1888 and 1890 maps, the location of the original Siding 29 station building is shown on the south side of the mainline, between the mainline and the siding tracks. A recent examination of this area revealed a disturbed area. No surface evidence was found of a station building. Limited archaeological testing revealed structural remains. It is not yet clear, however, whether these remains relate to the Siding 29 or a later occupation of the site.

CONCLUSIONS

The archaeological/historical investigations into the location of Siding 29 represent at a broad level, a piece of Banff history refound. New GIS mapping technologies have allowed researchers to easily digitize historical maps and photographs to facilitate overlay and analysis with the modern landscape. With this process, both known and newly discovered historic features have come to light, and previously recorded features have been assigned new provenience and context.

Although several historic features relating to Siding 29 have been identified, numerous others still need to be found. The station, numerous shacks and tenting areas and the miscellaneous traces left behind from historic settlement all need to be located and documented.

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This same mapping and analysis process is also being used at historic sites like Anthracite, Silver City, and Bankhead. These historic plans and maps, once digitized and overlain onto the modern landscape photomosaic, promise to reveal much that was once hidden.

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BUILDING CAPACITY FOR BIOSPHERE RESERVES: Enhancing Opportunities and Reducing Constraints

Krista Tremblett

Protected areas have become a necessary part of protecting natural systems, but an insufficient means alone to maintain biodiversity and ecological processes[1]. This is primarily because intensive development and other human activities adjacent to parks create conditions that limit the ecological functions of protected areas. In the last decade, Ecosystem-Based Management (EBM) has emerged as an alternative model for integrating protected areas management in a regional context. Currently, EBM programs are being implemented at many national parks, including Waterton Lakes National Park (WLNP), which is included in the case study conducted for this thesis.

WLNP in Alberta is a part of a greater area known as the "Crown of the Continent." The park is among the most discussed examples of ecosystem management. It was within the "Crown of the Continent" region that the world's first International Peace Park was established. WLNP and Glacier National Park (GNP) were jointly commemorated as the Waterton-Glacier International Peace Park and received World Heritage designation in 1995. In addition, WLNP and GNP were designated as a biosphere reserve by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1979. The biosphere reserve concept—a product of UNESCO's Man and the Biosphere program—provides a framework for managing protected areas and adjacent lands that promotes a balanced relationship between humans and the environment. It does this primarily through linking scientific research with education and sustainable development in the context of local communities. The biosphere reserve approach is aimed at generating local support for conservation, thus protecting natural systems and maintaining sustainable human activities. Biosphere reserves are potential tools for facilitating the application of EBM across protected areas and working landscapes.

To better understand the viability of biosphere reserves it is necessary to examine them in practice. My graduate research features a case study of the Waterton Biosphere Reserve (WBR), which will contribute to an understanding of why and how biosphere reserves are tools to practice, explore, and demonstrate EBM. More specifically, the purpose of my research is to contribute to an understanding of the opportunities and constraints of applying the biosphere reserve concept.

The rich diversity of flora and fauna coupled with a complex mix of public and private ownerships and resource development make the WBR an ideal location in which to study EBM. Many different land uses take place in this southwestern corner of the province including, oil and gas, forestry, tourism, recreation, ranching, residential development, and Blood Tribe multiple use lands. All of these activities can put ecological stress on the park and the landscape as a whole. Thus, it is considered both a priority and a challenge to balance the socio-economic objectives associated with these activities with

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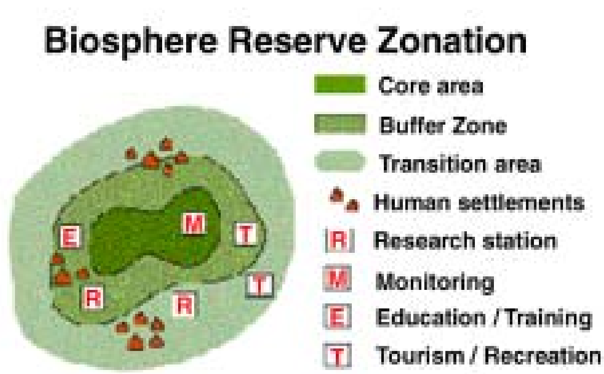
Trivia Regarding the Waterton Biosphere Reserve

(From: UNESCO Biosphere Reserve Directory http://www2.unesco.org/mab/br/brdir/directory/biores.asp?mode=all&code=CAN%2002)

- Established in 1979
- Size—Total 52, 597 hectares, Core area 46, 285 hectares, buffer zone 6, 312 hectares, transition zone extending 20 km to the east and north of WLNP, no defined area
- Administration—Waterton Biosphere Reserve Association
- Research
- Elk-Livestock range interactions (1985)
- Invasive species management along the Waterton and Belly Rivers (collaboration with Peigan First Nation Reserve, 1999)
- Waterton Biosphere Reserve Land Use Change Study (2000)
- Community-based ecological monitoring (collaborative effort between WBR and the Ecological Monitoring and Assessment Network (EMAN), 2002)
- WBR Ecotourism graduate project (2001)
- Smithsonian-MAB monitoring plots established in grassland ranching area (on-going)



UNESCO 1999. http://www.unesco.org/mab

[1] Brunckhorst, D.J. 2000. Bioregional Planning: Resource Management Beyond the New Millennium. Harwood Academic. Amsterdam, the Netherlands. 162p.

GENERAL INFORMATION ON BIOSPHERE RESERVES

What is a biosphere reserve?

Biosphere reserves are areas of terrestrial or coastal/marine ecosystems, which are internationally recognized within the framework of UNESCO's program on Man and the Biosphere. The aim of the biosphere reserve concept is to explore and demonstrate approaches to conservation and sustainable development on a regional scale. The functions of a biosphere reserve include:

- Conservation—contribute to the conservation of ecosystems, landscapes, and genetic diversity;
- Development—foster economic and human development that is socio-culturally and ecologically sustainable; and,
- Logistic support—provide support for demonstration projects, education and training, and research and monitoring.

Biosphere reserve zonation:

Biosphere reserves are traditionally organized into three zones:

- Core area—a legally constituted core area is devoted to long-term protection, and is of sufficient size to meet conservation objectives;
- Buffer zone—area surrounding the core zone where only low impact activities are allowed, such as research and education; and,
- Transition zone—the outer zone where sustainable land use practices are conducted and the impacts of these activities can be compared to zones of greater protection.

Criteria for designating a biosphere reserve:

- Biogeographic representation—encompass a mosaic of ecological systems, including a gradation of human activities;
- Significant for biodiversity conservation;
- Provide sustainable development opportunities;
- Size;
- Zonation;
- Multi-stakeholder involvement;
- Mechanism to manage human use and activities;
- Management policy;
- Designated authority to implement policy; and,
- Research, monitoring, education, and training programs.

UNESCO encourages the development of management plans for biosphere reserves. In the Canadian context, biosphere reserves have no legislated authority over land or resource use. Therefore management plans are not the appropriate tool. Instead, the Canadian Biosphere Reserve Association (CBRA) has developed a set of guidelines for the preparation of cooperation plans, which support the process of cooperation among stakeholders.

Why are biosphere reserves useful tools?

- They can be used to conduct comparative research on the structure and dynamics of minimally disturbed natural systems of the core areas, and the functioning of human-affected landscapes in the buffer and transition zones;
- They serve as mechanisms to share knowledge and skills in the form of education, research and monitoring, and demonstration sites; and,
- They provide local people an opportunity to have more influence in land-use decision making.

the conservation goals associated with the park. Other reasons for selecting the WBR as a case study for this research include:

- Waterton has been identified as among the best examples of co-operation of among diverse groups benefiting national parks including hunters, ranchers, environmentalists, parks staff and NGO's such as the Nature Conservancy of Canada (NCC);
- Partnerships between NGO's such as the NCC and ranchers have successfully addressed issues of conservation, development, and culture;
- The Waterton Biosphere Reserve Association has sought out solutions to environmental problems by engaging the community through locally relevant information and educational forums; and,
- The WBR is a part of the greater 'Crown of the Continent' ecosystem. Therefore, the protection of ecological values in this area is not only significant locally, but nationally and internationally as well.

The research for this thesis will be obtained using two methods: literature review and semi-structured interviews. The literature review has three objectives:

1. Document the fundamental principles of EBM and the defining elements of biosphere reserves,
2. Review documents featuring other Canadian biosphere reserves and,
3. Review documents relevant to the WBR (e.g., resource management plans).

This comprehensive review will be used to identify the role of the biosphere reserve in EBM, how and why other biosphere reserves succeeded or failed, and the opportunities and constraints of applying the biosphere reserve concept.

The semi-structured interviews will be conducted to explore the experiences of a biosphere reserve in practice. This will help determine the viability of the biosphere reserve concept as an EBM tool. Interview

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participants representing various stakeholder groups will be selected based on their connection to the Waterton region (i.e., individuals who live or work in the WBR), and willingness and availability to participate in the study. Other key people involved with biosphere reserves within Parks Canada, the Canadian Biosphere Reserve Association, and academia will also be interviewed. The interview topics will include: issues and concerns; interests and needs; perceptions of the biosphere reserve concept; and, perceptions of other stakeholders. The analysis and organization of information from the interviews will identify:

- Salient themes and patterns of meaning for participation in the biosphere reserve;
- Commonalities between patterns of meaning for different stakeholders; and,
- Opportunities and constraints for applying the biosphere reserve concept.

The information synthesized from the WBR case study and the salient themes derived from the literature will be used to identify the opportunities and constraints of applying the biosphere reserve concept. Recommendations to reduce constraints and enhance opportunities will be developed from 1) other biosphere reserve experiences reviewed in the literature 2) expert knowledge and 3) specific details, stories, and examples from the WBR interviews.

To conclude, central to this thesis is the premise that EBM is an ideal approach for addressing issues between protected areas and adjacent lands. Furthermore, this research asserts that biosphere reserves are a tool to apply EBM specifically by addressing issues of environment and development through cooperative management. The suggestions I propose may offer ways to increase the capacity of biosphere reserves. In addition, I hope that the recommendations developed from this research will provide insight into possible strategies for overcoming the constraints facing the full integration of the biosphere reserve concept into EBM initiatives in Canada.

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Recently In Print

Boulanger, J., G.C. White, B.N. McLellan, J.G. Woods, M.F. Proctor, and S. Himmer. 2002. A meta-analysis of grizzly bear DNA mark-recapture projects in British Columbia. Ursus 13:137-152

MacHutcheon, A.G., and D.W. Wellwood. 2002. Assessing the risk of bear-human interaction at river campsites. Ursus 13:293-298

MacHutcheon, A.G., and D.W. Wellwood. 2002. Reducing bear-human conflict through river recreaton management. Ursus 13:357-360

Proctor, Michael. 2003. Genetic analysis of movement, dispersal and population fragmentation of grizzly bears in southwestern Canada. PhD Thesis. University of Calgary.

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Meetings of Interest

November 19-22, 2003 Society for Ecological Restoration International's "Assembling the Pieces" Restoration, Design & Landscape Ecology." Austin, Texas. This conference will focus on design aspects of restoration, with the expectation of significant participation by landscape architecture, land planning, civil engineering and landscape ecology professionals. See the website: www.ser.org/meeting.php?pg=2003conference

February 26-29, 2004 7th Prairie Conservation and Endangered Species Conference 2004: Keeping the Wild in the West. Calgary, AB. This conference has a tradition of excellence due to strong support and attendance from a broad cross-section of society, including conservation groups, industry, government and academics. Keeping the Wild in the West will focus on sharing information and ideas on conserving prairie ecosystems, and will be of interest to a wide range of participants from the agricultural community, First Nations, energy industry, government agencies, municipalities, universities and conservation groups. Sessions will emphasize ecosystem management, species at risk, cooperative conservation programs and future challenges related to rural, diversification, urban sprawl and habitat restoration. Register at: www.PESC.ca or info@pesc.ca

March 2-6, 2004 Species at Risk 2004: Pathways to Recovery. Victoria Conference Centre, Victoria, BC. Join us to explore diverse and expanding pathways to recovery. This conference will explore species at risk topics and issues within BC and those jurisdictions with which BC shares ecological regions. Training sessions and workshops focusing on species at risk recovery processes will be relevant to delegates from within and beyond these regions. Themes include: Science of recovery; mechanics and logistics of recovery; human face of recovery and stewardship; successes and challenges – lessons from the field. Register on-line at: www.speciesatrisk2004.ca

May 2-6, 2004 Fourth World Fisheries Congress. Vancouver, BC. The congress theme, Reconciling Fisheries with Conservation: The Challenge of managing Aquatic Ecosystems, will be addressed by a world class list of speakers, session topics, posters, presentations, round table discussions etc. Contact Advance Group Conference Management Inc. Tel: (604) 688-9655; fish2004@advance-group.com; http://www.worldfisheries2004.org

June 6-10, 2004 North American Benthological Society 52nd Annual Meeting. University of British Columbia, Vancouver, BC. In addition to speakers and other presentations, there will be a variety of recreational, educational and research-related field trips during this conference. Contact John Richardson: jrichard@interchg.ubc.ca; http://faculty.forestry.ubc.ca/richardson/NABS2004.htm