Bear Conservation in a Fast-Changing North America

October 24–26, 2006
Revelstoke, British Columbia
Canada

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- National Wildlife Federation
- Parks Canada
- Revelstoke Community Forest Corporation
- University of Alberta
- University of Calgary
- University of Montana
- Wildlife Genetics International

The co-Chairs of the organizing committee were Dr. John Woods (Parks Canada) and Dr. Bruce McLellan (BC Ministry of Forestry and Range). Dr. Woods and Dr. McLellan also acted as our Masters of Ceremonies. Jackie Morris of the Columbia Mountains Institute provided administrative support for the conference.

Special thanks to our volunteer assistants, Abby Pond and Marcia Woods, who helped with the registration desk, posters, and the many other details that kept the conference running smoothly.

Our presenters travelled from Alberta, Montana, and various communities in British Columbia. We are grateful for their participation and for the support of their agencies in sending them to our conference. Thanks also to the participants that brought along exhibits and posters about their work.

Conference Description

Bears and people face a fast-changing world. Bear habitat is changing due to a variety of factors such as roads, rural settlement, resource extraction, and climate change. The past decade has seen rapid advances in the ways professionals gain insight into bear biology. New research tools include DNA fingerprinting, isotopic analysis, telemetry, and GIS-related data modelling. The idea for this conference grew out of the need for professionals to keep pace with these changes and to anticipate emerging issues in bear conservation and management.

Conference objectives

This conference was designed to accomplish the following:

- Inform participants about the significant changes facing bears in western North America with an emphasis on grizzly bears
- Inform participants about the latest field and analytical tools being used to understand bear biology and address potential change in bear habitat
- Encourage the exchange of information about works-in-progress and completed research projects, through a poster session and opportunities for informal dialogue

This conference included two days of presentations, a poster session, opportunities for informal dialogue, and two post-conference field trips. Dr. Andrew Derocher presented an evening talk, open to conference participants and the public, on "Polar bears and climate warming: Symptoms and consequences."

About 125 people attended the conference. Participants were multidisciplinary, and included staff from various government offices, resource managers, public interest groups, consulting biologists, protected area staff, and academia. Two senior biology classes from Revelstoke Secondary School attended portions of the event.

About the Columbia Mountains Institute of Applied Ecology

The Columbia Mountains Institute of Applied Ecology (CMI) is a non-profit society based in Revelstoke, British Columbia. The CMI is known for hosting balanced, science-driven events that bring together managers, researchers, educators, and natural resource practitioners from across southeastern British Columbia. CMI assists researchers with project administration. Our web site offers many resources, including workshop summaries for all of our past events.

Conference Agenda

Tuesday, October 24, 2006

8:45 a.m.	*Session Chair, Dr. John Woods* Welcome from the Columbia Mountains Institute Welcome from the City of Revelstoke, Councillor Nelli Richardson Welcome from the Ktunaxa Nation Overview of conference
9:00 a.m.	**Bear conservation in a fast-changing North America—What challenges do bears face?** Dr. Bruce McLellan, BC Ministry of Forests and Range
9:25 a.m.	**Changes in salmon dynamics and the implications for coastal bears**, Stefan Himmer, Arctos Wildlife Services
9:50 a.m.	**Changing wildfire and insect disturbance regimes in British Columbia**, Dr. Brad Hawkes, Canadian Forest Service
10:15 a.m.	*Coffee break*
10:35 a.m.	**The future of huckleberries: Implications for bears**, Evelyn Hamilton, Research Branch, BC Ministry of Forests and Range
11:00 a.m.	**Case study: Polar bears in a warming Arctic**, Dr. Andrew Derocher, University of Alberta
11:30 a.m.	Discussion period
Noon	Lunch, provided
	Session Chair, Dr. Bruce McLellan
1:00 p.m.	**Recovery of Yellowstone grizzlies: How we got there and why**, Dr. Chris Servheen, University of Montana
1:30 p.m.	**Bear viewing at Knight Inlet Lodge**, Tim McGrady, Knight Inlet Lodge
2:00 p.m.	**Changes in human attitudes toward bears**, Emily Chamberlain, Canadian Wildlife Service
2:30 p.m.	*Coffee-on-the-fly*
2:35 p.m.	**Future of bear hunting**, Dr. Sterling Miller, National Wildlife Federation, Montana
3:00 p.m.	Discussion period
3:30 p.m.	**Posters and beer social**
4:30 p.m.	End of day

Evening Speaker (open to the public)

Polar bears and climate warming: Symptoms and consequences
Dr. Andrew Derocher, University of Alberta
7:30 p.m. at the Revelstoke Community Centre

Wednesday, October 25, 2006	
	Session Chair Dr. John Woods
9:00 a.m.	**Provisions for grizzly bear management in regional and forest management plans—Are they working to benefit bear populations?** Tony Hamilton, BC Ministry of Environment
9:30 a.m.	**Changing silvicultural practices: Identification and buffering of important habitat features**, Rob Serrouya
9:55 a.m.	**Population fragmentation: Causes, implications, and solutions**, Dr. Michael Proctor
10:15 a.m.	*Coffee break*
10:30 a.m.	**The modern researcher's toolkit: Technology and the changing face of research and monitoring**, Clayton Apps, Aspen Wildlife Research
11:00 a.m.	**Recent advances in DNA mark-recapture methods to estimate population size and trend**, John Boulanger, Integrated Ecological Research
11:30 a.m.	Discussion period
Noon	Lunch. On your own, explore Revelstoke!
	Session Chair, Dr. Bruce McLellan
1:30 p.m.	**Brown bear management in Alaska: Perspectives of four retired Alaska Department of Fish and Game biologists**, Dr. Sterling Miller, National Wildlife Federation, Montana
2:00 p.m.	**A review of genetic methods for studying small populations**, Dr. David Paetkau, Wildlife Genetics International
2:25 p.m.	*Coffee-on-the-fly*
2:30 p.m.	**Models used to extrapolate grizzly bear populations in British Columbia**, Garth Mowat, BC Ministry of Environment
3:00 p.m.	**Managing the grizzly bear harvest in British Columbia**, Matt Austin, BC Ministry of Environment
3:30 p.m.	Discussion period
3:45 p.m.	**Conference observations**, Dr. Stephen Herrero, University of Calgary
4:00 p.m.	Conference wrap-up

Presentations for the morning of October 24, 2006

The conference began with a welcome from the Columbia Mountains Institute (CMI), given by our Master of Ceremonies for the morning, Dr. John Woods (past president of CMI). Nelli Richardson, Councillor for the City of Revelstoke, welcomed the participants and invited them to enjoy their stay in Revelstoke. Dr. Woods read a letter of welcome from the Ktunaxa Nation. He also gave an overview of the event and thanked the conference sponsors.

1. Bears in a fast-changing world: An introduction to factors influencing the abundance and distribution of bears

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Introduction

Bears, being large, long-lived omnivores like ourselves, are complex animals. This complexity, combined with great variations in density in the different regions, suggests that understanding their ecology is difficult. However, bears have been studied in many areas for many years and the complexity of their ecology, or factors that influence their abundance and distribution, are becoming clear. I believe the major factors that determine their abundance can be simplified to:

- habitat quality,
- the number of people in the area, and
- the behaviour of these people with respect to bears.

The goal of my presentation is to briefly expand on these three factors to create a framework for other more detailed talks and discussions.

Habitat quality

For this talk, habitat quality is defined as the rate at which bears obtain nutrients, which is dependent on food quantity, quality, distribution, and availability. Being omnivores, bears usually have many dietary options that vary greatly in the above factors. Most regions have some densely packed and very high-quality nutrients that are contained in the bodies of other animals such as fish, mammals, and insects. These organisms, however, have evolved mechanisms to avoid being eaten; therefore they are rarely available in sufficient quantities for bears to focus on for extended periods of time.

An exception, of course, is salmon. These anadromous fish forage across the expanse of the North Pacific Ocean for several years before spawning. They effectively concentrate nutrients over a huge area for the benefit of bears waiting at optimal locations to catch the fish. Although social constraints among bears may limit the use of prime fishing areas to those that are more dominant, most bears living along the Pacific coastline of British

Columbia, Alaska, and Russia find sites for fishing (Hilderbrand *et al.* 1999). Fishing is more rewarding than feeding on other foods, because the heavy concentrations of salmon present a high quality, and often highly available, food source. The density of bears in areas with spawning salmon is often one or two orders of magnitude higher than areas without salmon (Miller *et al.* 2003).

Ungulates, beavers, marmots, ground squirrels, and, on occasion, other bears, are also concentrated parcels of nutrients, but generally they have anti-predator strategies that make them less available. In locations where such animals are abundant, particularly where some are seasonally vulnerable, they are significant sources of bear foods.

In most areas without salmon, vegetation dominates bear diets. Because of the huge variety of food quantity, quality, distribution, and availability, bears are often confronted with complex foraging decisions. They trade off foraging on relatively predictable and abundant, but low quality, vegetative foods with spending more time handling or searching for less abundant, but higher quality foods— such as certain roots, corms, berries, nuts, or animal tissue. Some bears may rapidly ingest abundant, but low-quality vegetative foods, but instead of remaining in the area until the patch is depleted, they move to other patches to seek out unpredictable, but higher quality foods, such as animals. This foraging strategy predicts that bears do not consume an abundant vegetative food until a patch is depleted to the average, overall ingested rate as predicted by the marginal value theorem (Charnov 1976), but move from a patch long before it is depleted. Even more than the distance (time) between patches and depletion rate, the retention time in a patch would be a function of the relative quality and probability of encountering a high quality, but rare, food item.

While making foraging decisions about a great variety of foods of varying quality and distribution, there is likely a minimum threshold of food required to make the animal stop and feed. If there is too little food for a sufficient ingestion rate for the particular ecosystem and season, then the bear will likely move on in search of a better patch. But, there is likely an upper threshold of abundance as well, where having more food does not increase the ingestion rate. In riparian habitat in the Flathead River drainage, there appears to be a lower and upper threshold for consumption of cow parsnip (*Heraculum lanatum*), a major forb food. Selection plateaus at a moderate abundance.

In late summer, many plants put considerable energy into producing seeds and fruits. In many areas without salmon, bears develop most of the fat needed for hibernation by eating seeds such as nuts (acorns, pine nuts, etc.) and fruits. In the Flathead drainage, three female black bears that weighed 53, 45, and 36 kg in July, gained 0.86, 0.76, and 0.41 kg/day (or between 20 and 60 percent of their lean body weight) in August eating primarily huckleberries and buffalo berries. While small bears such as female black bears can develop fat rapidly by eating berries, it is unlikely that larger bears can consume small fruits at a significantly faster rate, and thus berries may not be a suitable food for large grizzly bears (Welch *et al.* 1997). Male grizzly bears rarely grow large in areas that do not have more concentrated food sources than berries. However, the density of bears, particularly smaller bears, can be high in areas where fruit is the primary autumn food, provided there is little competition with other species (common with tropical/subtropical bears).

In summary, habitat quality is complex at the mechanistic scale because bears have a very diverse diet of foods that vary greatly in quantity, quality, distribution, and availability. At more general scales of understanding, habitat quality is more easily quantified. Areas with foods such as salmon have very high-quality habitats. Areas with an abundant mix of herbaceous foods and fruits are also of high quality, particularly for bears with small bodies. Areas with dispersed low-quality foods, with some unpredictable sources of high-quality foods such as ungulates, may support large bears, but few of them, and they may have infrequent reproduction.

Habitat quality is dynamic and the mechanisms of change are often caused by humans. Converting land from primary forest to agriculture, and then from agriculture to settlement, is gradually eroding bear habitat in many parts of the world. Even well-managed, sustained-yield forest plantations may decrease in overall habitat quality because of the extended period of mid-seral plantations. These, and a multitude of other human-influenced habitat changes, are entangled with global climate change that will no doubt have a great effect on the quality of bear habitat. Some changes, such as increased natural fire, may be beneficial for some species, but the added destabilizing stress on ecosystems will likely be harmful to bear habitat in most instances.

Human abundance

The number of people on earth is rapidly increasing. Although this increasing number may have an effect on bear-habitat quality through an increased demand on resources, in British Columbia we are interested in the direct effect people have on bear behaviour and survival. Even in British Columbia, however, the human population has rapidly increased. In 1946 there were 1 million people. The number doubled by 1967, doubled again to 4 million in 1998, and is over 4.3 million in 2006. However this population increase is not distributed evenly. The number of urban people, or those living in a "built up area having a population of over 1,000" has increased rapidly from 800,000 in 1951 to 2.6 million in 1991, and then to 3.3 million in 2001. The rural population has decreased from 642,000 in 1991 to 600,000 in 2001. The number of people residing in and using in bear habitat has increased in some areas, but decreased in others. Generally, however, access is improving over most areas and thus a general increase of people using bear habitat is probable.

The presence of people in bear habitat affects bears in two main ways. First, human presence adds the factor of risk to the foraging decisions of bears. No longer are these decisions limited to trade-offs among quantity, quality, distribution, and availability of food (and some risk from other bears); bears must also incorporate the risk of a deadly encounter with people. The influence on this risk may change with each individual bear's experience through habituation and conditioning, but generally, risk from humans usually results in food sources near people (or where people are often encountered) being used less by bears than they would be if people were not there.

Second, people affect bears by killing them. The probability of a person killing a bear is the product of the encounter rate and of the kill rate per encounter. In general, the human/bear encounter rate is proportional to the number of people. Thus, the more people, the more encounters, and the more encounters, the more dead bears. However, the relationship between the number of people and the encounter rate, in particular the kill rate per encounter, depends largely on human behaviour.

Human behaviour

Of the three factors that influence bear numbers, the factor of change in human behaviour, at least in western North America and Europe, has likely had the greatest influence on bear populations. Human behaviour was largely responsible for the regional extinction of bears across large portions of North America and parts of Europe, Human/bear encounters, and kills per encounter, were often a goal. Conversely, in places such as national parks, there may be a large number of people but they are forced by laws to behave in certain ways. In these locations, encounter rates are relatively low, kills per encounter are extremely low, and bears usually thrive.

Bear hunting is a human behaviour that both increases human/bear encounter rates and kill rates per encounter. In British Columbia, grizzly bear hunting permits have been on a limited entry draw for residents, or on a quota for non-residents, for the past 30 years. This system not only limits the legal harvest, but provides a more precise estimate of killed animals than does the system of holding general open seasons. In British Columbia, the black bear hunt is regulated by a general open season but there are few hunters for the large population of these bears, and the effect of harvest on their population status is minimal. Other hunters, such as those interested in ungulates, also encounter and kill bears, but, in British Columbia the number of hunters is rapidly decreasing and those that do still hunt are more tolerant of bears than they once were. In other jurisdictions, such as portions of Alaska, hunting is not as strictly controlled as it is in British Columbia. The management objective in some parts of Alaska includes reducing bear numbers in the hope that certain ungulates will become more abundant (thus making it easier to hunt ungulates).

In many rural areas, bears were once attracted by garbage, fruit trees, or compost, and were often shot when seen. Today, many people are reducing these attractants around their property, which is decreasing encounter rates. Even when an encounter does occur, people who see bears near their residences rarely shoot them. It is probable that human behaviour towards bears will continue to improve.

Conclusions

The future of bears depends on the quality of their habitat, the number of people, and the behaviour of these people. These factors not only vary among bear species but also across the distribution of each species. Of these factors, the behaviour of people is the most easily changed. While the number of people is going to increase, human populations in bear habitat can be limited using access control. Changes to bear habitat are complex and must be managed with greater ecological understanding of specific areas.

References

Charnov, E.L. 1976. Optimal foraging, the marginal value theorem. Theor. Pop. Biol. 9:129–136.

Hilderbrand, G.V., C.C. Schwartz, C.T. Robbins, M.E. Jacoby, T.A. Hanley, S.M. Arthur, and C. Servheen. 1999. The importance of meat, particularly salmon, to body size, population productivity, and conservation of North American brown bears. Canadian Journal of Zoology 77:132–138.

Miller, S.D., G.C. White, R.A. Sellers, H.V. Reynolds, J.W. Schoen, K. Titus, V.G. Barnes, Jr., R.B. Smith, R.R. Nelson, W.B. Ballard, and C.C. Schwartz. 1997. Brown and black bear density estimation in Alaska using radiotelemetry and replicated mark-resight techniques. Wildlife Monographs 133. 55 pp.

Welch, C. A., Keay, J. K. Kendall, K.C. and Robbins, C. T. 1997. Constraints of frugivory by bears.Ecology 78(4): 1105–1119.

2. Changing salmon dynamics and the implications for coastal bears

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Global climate change and climate oscillations can have major effects on Pacific salmon populations. It has already been shown that the last decade has been the warmest in over a thousand years. As well, the North Pacific Ocean is a complicated place, with a complicated ecology.

Several different regimes or environmental conditions have recently been identified. They include the following:

- El Niño–Southern Oscillation (ENSO)
- Pacific Decadal Oscillation (PDO)
- North Pacific Gridded Optimally Interpolated Sea Surface Temperature (SST)
- Sea Level Pressure (SLP)

During ENSO events the southerly portions of the North Pacific warm up, resulting in poor ocean survival for salmon. This occurred in 1957, 1983, and 1997, and caused very poor salmon returns. Based on analyses of temperature, pressure, tree ring, and salmon catch records, several researchers have hypothesized that other shifts in climate regime have occurred in the North Pacific during the last century. These climate regime shifts have been termed Pacific Decadal Oscillation or “PDO.”

PDO has been described as a long-lived, ENSO-like pattern of Pacific climate variability, characterized by abrupt transitions in atmospheric and marine physical conditions that are

stable and can persist for 20–35 years. It is not known how ENSO relates to PDO. These PDO regimes have been correlated with:
above average salmon production from 1925–1946;

- lower salmon production and disappearance of pilchards from the BC coast from 1947–1976:
- a recovery in salmon populations from1977–1988; and
- lower salmon returns to the Fraser River from 1989–1998.

Other biological responses to PDO have been seen. For example, marine phytoplankton productivity has undergone changes, which then affects zooplankton productivity and, in turn, fish productivity. Linkages between these oceanic physical processes and salmon production are poorly understood but probably occur early in the life stages of marine organisms as they move from freshwater to nearshore marine systems. Terrestrial environments in Alaska have been relatively warm and wet in the late 1990s, corresponding to a positive phase of PDO resulting in high stream flows. High flows are good for several stages of salmon life history because they allow spawner returns to small streams and enhance the survival of smolts during seaward migration due to reduced vulnerability to freshwater predators. Years with high stream flows also coincide with years of favourable nearshore marine conditions.

Other factors such as sea surface temperature (SST) and sea level pressure (SLP) act on large spatial scales. They are generally implicated in regime shifts and are therefore important indicators of habitat change that is likely to influence biological activity. As well, surface water salinity has been declining over vast areas of the North Pacific since the late 1990s, which also has implications for marine phytoplankton production.

A recent report by the Coast Information Team in British Columbia has determined that, in general, salmon stocks are declining in Haida Gwaii, and in the central and north coast waters of British Columbia. Along the US coast south of British Columbia, salmon runs are less than 10% of historic pristine levels. Only in Bristol Bay, Alaska, and to a lesser extent along the entire Alaska coast, are salmon runs still considered healthy relative to historic records. These declines in salmon abundance have undoubtedly had impacts on coastal bear populations.

In one area of the central British Columbia coast, the sockeye salmon runs almost crashed completely. The Owikeno Lake runs historically ranged from 500,000 to 1.5 million and supported a large cannery system. In 1999, the estimated escapement fell to 5,000 sockeye returning to spawn. In 1998, John Boulanger and I started a grizzly bear research project to test different methods of determining grizzly population trends along salmon streams in the Owikeno area. This enabled us to document the effects of a salmon crash on bears relying on this resource. We conducted yearly sampling of three watershed areas during peak salmon escapement using barbed wire DNA sampling on bear trails adjacent to salmon streams. The yearly data was pooled and salmon availability was also monitored. DNA mark-recapture estimates from 1998–2002 showed there were 43 (annual range 3–26) bears using the Chuckwalla/Ambach area, 52 bears (4–28) in the Neechanz/Genesee area, and 28 bears (0–16) in the Washwash/Inziana area. Salmon availability varied greatly from year to year.

Grizzly population-trend estimates suggested that salmon availability was too low in the first two years of the study to sustain bear populations; all sampling areas had negative population growth in 1999 and 2000; in 2001 and 2002 there was a slight increase in population. When the data was pooled for all areas, the superpopulation showed similar trends to the individual watershed areas. We also found that bears showed a high fidelity to individual stream complexes with only 4 of 123 bears moving between sampling areas.

Salmon are important to coastal bears because they are a predictable, dependable, concentrated, and accessible source of fat and protein that is available at an ecologically important time period prior to hibernation. For female bears, this is important for gestation and lactation. Pacific Coast bear populations have adapted to this nutrient-rich food source by having relatively high population densities. Coastal bears have had to respond to intraspecific competition (e.g., predation) at higher population densities by maximizing their body size, increasing litter sizes, and reducing interbirth intervals. Bears have home ranges in areas of high primary productivity and low seasonality. In contrast, interior and barren-ground bears lacking salmon or other reliable sources of meat are using risk-spreading adaptations to maintain healthy populations by increasing the age at maturity for females, increasing interbirth intervals, reducing litter sizes, and, generally, living longer. Generally, they live in areas of low primary productivity and high seasonality.

Many factors affect the availability of salmon to coastal bears. This includes changes in escapement (the number of salmon returning to streams to spawn) directly caused by changing recruitment, freshwater environmental conditions, commercial and sport fishing, hatchery management, predation by other marine species, marine environmental conditions (especially ocean regime patterns), and hydrological conditions during the spawning season. Anthropogenic factors such as climate change, dams, oil spills, pollution, logging, mining, agriculture, rural settlement, urbanization, and aquaculture may also directly or indirectly influence salmon escapement and availability to bears. Even activities such as ecotourism (bear viewing, etc.) and sport fishing on rivers may decrease or restrict access to salmon by bears. As salmon stocks decline, the duration and timing of salmon spawning is decreased. Where salmon once spawned in many rivers and streams over many months, now they may occur in only a handful of streams for a month or two. Intraspecific competition, especially in streams with decreasing salmon runs, may limit the time and area subordinate individuals have to feed on salmon.

Can coastal bears survive without salmon? Probably not. As already discussed, coastal bears are highly reliant on salmon to maintain high population densities, larger body sizes, and higher rates of reproduction. Coupled with this, there are few if any alternatives to nutrient-rich salmon. Coastal areas generally have fewer large ungulates and few other reliable meat sources exist there. Recent research with captive bears has indicated that there are constraints on herbivory and frugivory by large coastal bears, meaning they cannot gain the necessary fat reserves needed for hibernation by eating vegetation or berries alone. Even if they could use berries, coastal areas are generally not rich in *Vaccinium* species berry patches because there is a greater proportion of rock and ice on the coast compared with areas in the interior where berries are important to bears.

What are the implications of salmon population declines to coastal bears? Direct consequences are reduced individual fitness, especially for females who may then have a reduced reproductive capacity leading to population declines. Cub mortality may increase, and in extreme cases adult mortality may also occur because bears may not have enough fat reserves to survive hibernation. Bears may leave areas with low salmon availability for areas with more abundant salmon stocks, increasing intraspecific competition in these latter areas. In some areas, as salmon stocks dwindle, bears may be forced to exploit anthropogenic food sources such as garbage, orchard fruit, and pet and livestock foods, resulting in higher risks of mortality due to defence of life and property and control-action kills.

There are also implications to coastal riparian habitats from stock declines in salmon and the related population declines in coastal bears. Bears have been shown to be important transporters of marine nutrients into terrestrial areas. When bears kill spawning salmon and carry their carcasses into streamside areas to feed on them, soils and vegetation benefit from the uneaten portions and fecal matter left behind. This is shown by increased growth rates in trees and other plants compared to areas without salmon. Other organisms, such as aquatic insects, birds, and small mammals, also benefit from fresh salmon killed by bears, which are much higher in nutrients than those that die after spawning.

So how do we protect, enhance, and rehabilitate salmon stocks to benefit coastal bears and maintain rich coastal riparian environments? The key is to maintain the bio-complexity of salmon stocks. We should manage not only for large productive salmon streams which provide good commercial and sport fisheries, but also protect the smaller stream and lake systems, which may harbour the genetic variability required to survive complex environmental changes. Salmon stocks need to be managed with consideration of climate change and complex ocean regimes. We must increase habitat protection for spawning salmon and for rearing areas in freshwater and inshore marine environments through land use planning. More conservative salmon harvest strategies must be implemented and adapted to changing conditions. This would include moving away from high-seas fisheries to more easily controlled and managed terminal fisheries for salmon. Hatchery strategies need to be re-evaluated to determine if they actually benefit the long-term viability of salmon stocks. More research needs to be done on aquaculture, considering the real and potential impacts to salmon stocks, to justify its use and expansion.

Suggested reading

Beamish, R. J., Schnute, J. T., Cass, A. J., Neville, C. M., and Sweeting, R. M. 2004. The Influence of Climate on the Stock and Recruitment of Pink and Sockeye Salmon from the Fraser River, British Columbia, Canada. Transactions of the American Fisheries Society 133:1396–1412.

Ben-David, M., Titus, K., and Beier, L. 2004. Consumption of salmon by Alaskan brown bears: a trade-off between nutritional requirements and the risk of infanticide? Oecologia, 138: 465–474.

Boulanger, J., S. Himmer, and C. Swan. 2003. Monitoring of grizzly bear population trend and demography using DNA mark-recapture methods in the Owikeno Lake area of British Columbia. Can. J. Zool. 82:1267–1277.

Ferguson, S.H. and McLoughlin, P.D. 2000. Effect of energy availability, seasonality, and geographic range on brown bear life history. Ecography 23:193–200.

Gende, S. M, Quinn, T.P., Hilborn, R., Hendry, A.P., and Dickerson, B. 2004. Brown bears selectively kill salmon with higher energy content but only in habitats that facilitate choice. Oikos 104: 518–528.

Gende, S.M. and 2004. The relative importance of prey density and social dominance in determining energy intake by bears feeding on Pacific salmon. Can. J. Zool. 82: 75–85.

Gende, S.M., Quinn, T.P., and Willson, M.F. 2001. Consumption choice by bears feeding on salmon. Oecologia, 127: 372–382.

Hare, S. and N.J. Mantua. 2000. Empirical evidence for North Pacific regime shifts in 1977 and 1989. Progress in Oceanography 47: 103–145.

Hilborn, R., Quinn, T.P., Schindler, D.E., and Rogers, D.E. 2003. Biocomplexity and fisheries sustainability. Proc. Nat. Academy of Sci. USA 100: 6564–6568.

Hilderbrand, G.V., Farley, S.D., Schwartz, C.C., and Robbins, C.T. 2004. Importance of salmon to wildlife: implications for integrated management. Ursus, 15: 1–9.

Hilderbrand, G.V., Jenkins, S.G., Schwartz, C.C., Hanley, T.A., and Robbins, C.T. 1999b. Effect of seasonal differences in dietary meat intake on changes in body mass and composition in wild and captive brown bears. Can. J. Zool. 77: 1623–1630.

Hilderbrand, G.V., Schwartz, C.C., Robbins, C.T., and Hanley, T.A. 2000. Effect of hibernation and reproductive status on body mass and condition of coastal brown bears. J. Wildl. Manag. 64:178–183.

Jacoby, M.E., Hilderbrand, G.V., Servheen, C., Schwartz, C.C., Arthur, S.M., Hanley, T.A., Robbins, C.T., and Michener, R. 1999. Trophic relations of brown and black bears in several western North American ecosystems. J. Wildl. Manag. 63: 921–929.

Mantua, N. J., Hare, S.R., Zhang, Y., Wallace, J.M., and Francis, R.C. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society. 78:1069–1079.

McKinnell, S.M ., C.C. Wood, D.T. Rutherford, K.D. Hyatt and D.W. Welch . 2001. The demise of Owikeno Lake sockeye salmon. N. American J. Fish. Manage. 21 :744–791.

Quinn, T. P., Wetzel, L., Bishop, S., Overberg K., and Rogers, D. E. 2001. Influence of breeding habitat on bear predation and age at maturity and sexual dimorphism of sockeye salmon populations. Can. J. Zool. 79: 1782–1793.

Reimchen, T.E. 2000. Some ecological and evolutionary aspects of bear–salmon interactions in coastal British Columbia. Can. J. Zool. 78: 448–457.

Reimchen, T.E., Mathewson, D.,Hocking, M.D., and Moran, J. 2002. Isotopic evidence for enrichment of salmon-derived nutrients in vegetation, soil, and insects in riparian zones in Coastal British Columbia. American Fisheries Society Symposium XX:000–000, 2002

Robbins, C. T., Schwartz, C. C., and Felicetti, L.A. 2004. Nutritional ecology of ursids: a review of newer methods and management implications. Ursus 15(2):161–171.

Rode, K.D., Robbins, C.T., and Shipley, L.A. 2001. Constraints on herbivory by grizzly bears. Oecologia, 128: 62–71.

Rumsey, C. Ardron, J. Ciruna, K. Curtis T., Ferdaña, Z. Hamilton, A.N., Heinemeyer, K., Iachetti, P., Jeo, R. Kaiser, G. Narver, D., Noss, R., Sizemore, D., Tautz, A., Tingey, R.,and Vance-Borland, K. 2004. An ecosystem spatial analysis for Haida Gwaii, Central Coast, and North Coast British Columbia. Coast Information Team Report.

Schwartz, C. C., S.D. Miller, and Harolson, M.A. 2003. Grizzly bear. Pages 556–586 in Feldhamer, G.A., Thompson, B.C., and Chapman, J.A., eds. Wild Animals of north America: Biology, Management, and Conservation. Second edition. Johns Hopkins univ. Press. Baltimore Maryland. USA.

Welch, C.A., Keay, J., Kendall, K.C., and Robbins, C.T. 1997. Constraints on frugivory by bears. Ecology, 78: 1105–1119.

3. Climate change, forest fires, and insects in British Columbia

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Climate change will result in altered fire regimes and insect outbreaks in British Columbia. Understanding the changes in fire and insect activity, the geographic location and size of such activity, as well as the frequency, duration, severity, and impact that British Columbia can expect under climate change is extremely important for biodiversity (including bear conservation), timber supply, and community protection.

Many factors affect the abundance and distribution of herbivorous insects, such as climate, natural enemies, and availability of host plants (Gray 2005). Insect outbreaks are one potential result of the complex interactions among these factors. Most short-term, local changes in forest pest dynamics are due to land-use changes and other disturbances and/or natural fluctuations in distribution and abundance of insects (Carroll 2005). However, climate change is anticipated to significantly alter the form of these interactions. Consequently, it will be difficult to predict responses of insect populations to changing environments.

Some potential impacts of a warming environment on the biology of a forest insect include modified phenologies, distribution shifts, altered species interactions, and modified community dynamics. These impacts will likely affect the dynamics of forest insect pest populations through:

- altered outbreak frequency and/or duration,
- changing herbivory/damage rates,
- range expansion/contraction, and
- novel host species associations (Carroll 2005).

As an example, a warming environment has significantly affected the phenology of the spruce beetle (*Dendroctonus rufipennis* [Kirby]) over much of Alaska and the Yukon (Berg *et al.* 2006). Specifically, warmer summers have allowed populations to shift from a mainly semivoltine life cycle (two years to complete a generation) to a univoltine life cycle (one generation per year). This in turn has led to an increase in the rate of spruce mortality (Hansen and Bentz 2003).

Carroll (2005) proposed that the spatio-temporal ubiquity of a forest insect species will constrain the suite of landscape-level consequences associated with a changing climate. Within this framework, he defined four broad groups of potential insect pests:

- Native ubiquitous (insect range equals the range of preferred host)
- Native invasive (insect range does not equal the range of the preferred host)
- Native innocuous (insects that may or may not be ubiquitous, but historically do not occur in outbreak)
- Exotic invasive (introduced species)

Within the next 50 years, native ubiquitous and native innocuous pests should increase their impact through altered outbreak characteristics such as increased damage rates and perhaps novel host associations, while native and exotic invasives should increase their impact through range expansion.

Perhaps the best example of climate change impacts on a forest insect pest to date involves the mountain pine beetle (*Dendroctonus ponderosae* [Hopkins]). Carroll *et al.* (2004) used historic weather and digital terrain data to model climatic suitability across British Columbia for the period 1930–2000. They found that during the latter half of the 20th century, there was a substantial shift in climatically benign habitats for mountain pine beetle northward and toward higher elevations. More importantly, they found an increase (at an increasing rate) in the number of infestations in historically climatically unsuitable areas indicating that the beetle had rapidly expanded into these new climatically suitable habitats. In the past, large-scale mountain pine beetle outbreaks collapsed due to localized depletion of suitable host trees in combination with the adverse effects of climate (Safranyik 1978). Carroll *et al.* (2004) indicated that in the absence of an unusual weather event (i.e., an unseasonable cold period or an extreme winter), the current outbreak may not entirely collapse as in the past. As global warming continues, beetle expansion into new habitats will provide this pest with a small, continual supply of mature pine, thereby maintaining beetle populations at above-normal levels for some decades into the future.

Fire activity is strongly influenced by four factors: weather and climate; vegetation (fuels); natural ignition agents; and humans (Flannigan and Wotton 2001). Climate and weather are strongly linked to fire activity which suggests that the fire regime will respond rapidly to changes in climate (Flannigan 2006). Changes in fire regime may be due to changes in fire and forestry policy over time or changes in forest pest dynamics and their impact on fuels like mountain pine beetle (Keane *et al.* 2002). Flannigan (2006) indicates that the climate of the northern hemisphere has been warming due to an influx of radiatively-active gases (carbon dioxide, methane, etc.) as a result of human activities. This altered climate, modelled by General Circulation Models (GCMs), indicates a profound impact on fire activity in the circumboreal forest.

In Canada, weather and climate are the most important natural factor influencing forest fires (Gillett *et al.* 2004). Weather determines fuel moisture, causes lightning ignitions, and contributes to fire growth through wind action. However, the long-term average of area burned across a landscape is determined by a complex set of variables, which include the size of the sample area, the period under consideration, the extent of the forest, the topography, fragmentation of the landscape (rivers, lakes, roads, and agricultural land), fuel characteristics, season, latitude, fire suppression policies and priorities, fire control, organizational size and efficiency, fire site accessibility, ignitions (people and lightning), and simultaneous fires, as well as the weather. Recent results using GCMs suggest that in many regions, fire weather/fire danger conditions will be more severe, area burned will increase, people-caused and lightning-caused ignitions will increase, fire seasons will be longer, and the intensity and severity of fires will increase.

A collaborative research agreement between the BC Ministry of Forests and Range (MOFR) Protection Program and Natural Resources Canada (at the Northern Forestry Centre of the Canadian Forest Service [CFS]) was developed in July 2000 to determine the potential impact of climate change by assessing past, current, and future fire occurrence and fire severity in British Columbia. The CFS project team members were Mike Flannigan, Brian Stocks, Mike Wotton, Bernie Todd, Heather Cameron, and Kimberley Logan, and the MOFR project contacts were Judi Beck and John Flanagan. A project report was submitted to the MOF, Protection Program in 2002 (Flannigan *et al.* 2002). A summary of the British Columbia climate change and fire study was published in the 2005 proceedings of the conference on the "Implications of Climate Change in British Columbia's Southern Interior Forests," hosted by the Columbia Mountains Institute of Applied Ecology in Revelstoke, British Columbia (Hawkes *et al.* 2005).

Weather projections for western Canada, as modelled by the Canadian Regional Climate Model (RCM), were modified for British Columbia by applying elevation-correction routines to the 45 km grid cell RCM data. As well, spatial relationships were developed to transpose the RCM data from a non-spatial to a spatial structure at 5 km resolution. For each of three scenario periods, 1 x CO_2 (1975–1985), 2 x CO_2 (2040–2049), and 3 x CO_2 (2080–2089) (where 2 x CO_2 and 3 x CO_2 are doubling and tripling of CO_2 levels), daily weather and Fire Weather Index (FWI) maps were created. Current and future fire weather and danger scenarios for British Columbia were examined to better understand the potential changes in fire severity, and danger and length of fire season, over time.

Although the RCM simulations of the three scenarios for British Columbia indicate a gradual increase in temperature over the next 100 years, the increase is not as severe as the RCM predictions for the rest of western Canada. In general, for British Columbia, the RCM scenarios are predicting an increase in temperature of 1–2ºC by the year 2045 and 2–4ºC by the year 2085, an increase in fire season length of 1–2 weeks by the year 2045 and 2–3 weeks by the year 2085, and an increase in Seasonal Severity Rating (SSR) over the three RCM scenarios. Projections of area burned, for the Canadian boreal forest and western Canada, based on weather/fire danger relationships, suggest a 74–118% increase in area burned by the end of this century according to the Canadian and Hadley models, respectively (Flannigan *et al.* 2005).

Taylor *et al.* (2005a) have modelled forest fire probability for British Columbia using a logistic regression approach using mapped forest fires from 1960 to 2000. Logistic regression models were fitted to lightning-caused, person-caused, and all fire data against 17 explanatory variables. Most of the variables made a significant contribution to predicting person-caused and lightning-caused fires. Some variables like road density made a large contribution to explaining fire probability for both fire causes but for different reasons: there was a higher probability of person-caused fires near roads, whereas lightning fire probability was lowered with higher road densities, perhaps due to better access for fire suppression resources. Significant explanatory variables, such as FWI codes and indices, could be useful when combined with climate change fire danger scenarios since future changes in fire probability could be predicted using these fire danger scenarios.

Taylor *et al.* (1998) modelled changes in forest composition and density in five study areas in British Columbia's interior dry forests using 1950s and 1990s air photographs and the PrognosisBC growth and yield model. Their model showed that forest density and cover increased during the approximately 40-year period and predicted them to become even denser. This change in forest structure and density increased the number of days that crown fires would develop in a reference historic fire season. Climate change scenarios of fire weather and danger were linked to potential changes in forest conditions. In theory, this could lead to an even larger increase in the number of days in a fire season that crown fires would develop than without climate change.

Taylor *et al.* (2005b) examined whether there is an interaction between insect outbreaks and forest fire risk or amount of areas burned. Eleven common forest insects were examined including four species of bark beetle and seven defoliating species. The hypothesis tested was that if forest insect outbreaks affected fire activity there would be significant variation in the waiting time distribution between outbreak and fire occurrence. That is, if insects had no effect, then a uniform or random distribution of waiting time would be expected. Tests on the median values of the normalized burn-rate, waiting-time distributions suggested that mountain pine beetle, spruce beetle, western spruce budworm, and black headed budworm temporal patterns were significant. With potential changes, due to climate change, in insect outbreak frequency, intensity, and range (e.g., Carroll *et al.* 2004) coupled with potential changes in fire weather and danger, occurrence, and area burned, there could be a stronger link between insect and fire disturbances.

Blackwell *et al.* (2003) describes the development of a coarse-scale approach to the assessment of forest fuel conditions in southern British Columbia. The study area encompassed the southern interior of British Columbia spanning the Coast Mountains in the west to the BC–Alberta border in the east, and from 100 Mile House in the north to the BC–US border in the south (approximately 16.24 million hectares). The study attempted to address two key questions:

1) What is the potential scale of the fuels problem in British Columbia?
2) What is the potential risk to human life, property, and forest resources?

To answer these questions, researchers used an analysis framework developed in the US (Schmidt *et al.*2002) that linked Historic Natural Fire Regimes (HNFR—a descriptor of fire frequency and severity) to Condition Class (a measure of ecosystem departure from historic conditions and forest fuel risk). The condition class analysis was the first of its kind in British Columbia and provided an attempt to define some of the impacts of long-term suppression and the resulting risks to important social, economic, and biological resources. The study clearly demonstrated that suppression has increased the risk of fire in a significant area of the province, and that these areas of high risk are associated with key ecosystems, especially at lower elevations in the interior of British Columbia. There would have been less change at higher elevations, where the HNFR have longer intervals between forest fires.

How the fire regimes may change with climate change in the future will depend on how the regime components are affected. A fire regime is defined by the fire frequency, size/shape, season, and severity (depth of burn and aboveground consumption, e.g., tree crowns). Climate change impacts on vegetation dynamics will be influenced by changes in the fire regime components, as well as their interaction with other abiotic and biotic disturbances such as insects. If fires occur more frequently, the potential changes in vegetation types and dynamics will depend partly on how individual plant species are adapted to more frequent fires. Changes in fire seasonality could influence the response of vegetation after fire because it would shift their due to their phenological stage at burning. An increase in burn area may result in larger fires and fewer unburned islands within the fire boundary. This change could increase the distance seeds have to travel to germinate. The depth of burn on fires may increase if there are more and extended droughts resulting in drier forest floors. A fire's depth of burn directly influences seedbed characteristics, especially for those plant species that require mineral soil for germination. Increases in depth of burn can also influence the ability for vegetation to re-sprout due to an increase in root mortality. An increase in fire severity as expressed by above ground plant mortality could also impact plant succession by eliminating seed sources for re-vegetation. Hamilton and Haeussler (2006) established permanent vegetation monitoring plots on 12 clearcut and slashburned winter-logged mature spruce/subalpine fir/pine forested sites across broad climatic and geographic gradients in central British Columbia, and sampled repeatedly for up to 11 years. They found that resource availability, fire return interval, and fire severity were significantly correlated with major differences in post-fire plant community composition.

References

Alberta Sustainable Resource Development. 2006. Beetle Bulletin, July 26, 2006, Mountain Pine Beetle in Alberta. *www.srd.gov.ab.ca/forests/health/pdf/BeetleBulletin2006.pdf*

Berg, E.E.; Henry, J.D.; Fastie, C.L.; De Volder, A.D.; Matsuoka, S.M. 2006. Spruce beetle outbreaks on the Kenai Peninsula, Alaska, and Kluane National Park and Reserve, Yukon Territory: relationship to summer temperatures and regional differences in disturbance regimes. Forest Ecology and Management 227: 219–232.

Blackwell, B.A.; Gray, R.W.; Green, R.; Feigl, F. 2003. Developing a coarse scale approach to the assessment of forest fuel conditions in southern British Columbia. Final report, Forest Investment Innovation project R2003–0112, Victoria, B.C.. *www.for.gov.bc.ca/hfd/library/fia/html/FIA2003MR125.htm*

Carroll, A.L. 2005. Changing the climate, changing the rules: predicting forest pest impacts under global warming. Abstract, Pages 49–50, In: Proceedings of the Western Forest Insect Work Conference, March 29– April 1, 2005, Victoria, B.C. *www.fsl.orst.edu/wfiwc/proc/2005proc.pdf*

Carroll, A.L.; Taylor, S.W.; Régnière, J.; Safranyik, L. 2004. Effects of climate change on range expansion by the mountain pine beetle in British Columbia. Pages 223–232, in: T.L. Shore, J.E. Brooks, and J.E. Stone, editors. Mountain Pine Beetle Symposium: Challenges and Solutions, October 30–31, 2003, Kelowna, British Columbia, Canada. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, British Columbia, Information Report B.C. X-399. 298 pp. *http://warehouse.pfc.forestry.ca/pfc/25051.pdf*

Flannigan, M.D. 2006. Forest fires and climate change in Boreal Forests. Abstract in Proceedings of 3rd International Fire Ecology & Management Congress, Nov. 13–17, 2006, San Diego, CA (to be published as electronic proceedings on CD).

Flannigan, M.D.; Wotton, B.M. 2001, Climate, weather and area burned, in: Johnson, E.A. and Miyanishi, K., (ed.), Forest Fires: Behavior and Ecological Effects. Academic Press. pp. 335–357.

Flannigan, M.D.; Campbell, I.; Wotton, B.M.; Carcaillet, C.; Richard, P.; Bergeron, Y. 2001, Future fire in Canada's boreal forest: paleoecology results, and general circulation model—

regional climate model simulations, Can. J. For. Res. 31,854–864. *http://nofc.cfs.nrcan.gc.ca/bookstore_pdfs/18495.pdf*

Flannigan, M.; Wotton, M.; Todd, B.; Cameron, H.; and Logan, K 2002. Climate change implications in British Columbia: Assessing past, current, and future fire occurrence and fire severity in B.C.. Reported submitted to B.C. Ministry of Forests, Protection Program, 2002. Report in 8 sections.

Flannigan, M.D.; Logan, K.A.; Amiro, B.D.; Skinner, W.R.; Stocks, B.J. 2005. Future area burned in Canada. Climatic Change 72: 1–16.

Gillett, N.P.; Weaver, A.J.; Zwiers, F.W.; M.D. Flannigan. 2004. Detecting the effect of climate change on Canadian forest fires. Geophys. Res. Lett.. 31(18), L18211, doi:10.1029/2004GL020876.

Gray, D.R. 2005. The effects of climate change on insect outbreaks at the landscape scale– 2 insects– 2 questions– 2 techniques. Abstract, Pages 51–52, In: Proceedings of the Western Forest Insect Work Conference, March 29– April 1, 2005, Victoria, B.C. *www.fsl.orst.edu/wfiwc/proc/2005proc.pdf*

Hamilton, E.; Haeussler, S. 2006. Vegetation functional group response after slashburning across environmental gradients in central British Columbia, Canada, Abstract in Proceedings of 3rd International Fire Ecology & Management Congress, Nov. 13–17, 2006, San Diego, CA (to be published as electronic proceedings on CD).

Hansen, E.M.; Bentz, B.J. 2003. Comparison of reproductive capacity among univoltine semivoltine, and re-emerged parent spruce beetles (Coleoptera: Scolytidae). Can. Entomol. 135: 697–712.

Hawkes, B.; Flannigan, M.; Todd, B. 2005. Climate change and forest fire in British Columbia. Pages 21–30, in: Proceedings of “Implications of Climate Change in British Columbia’s Southern Interior Forests”, edited and published by the Columbia Mountains Institute of Applied Ecology, April 26–27, 2005, Revelstoke, B.C.. Available online at: *www.cmiae.org/pdf/ImpofCCinforestsfinal.pdf*

Intergovernmental Panel on Climate Change (IPCC) 2001. Climate Change 2001. The Scientific Basis, Cambridge University Press, Cambridge.

Johnson, E.A. 1992. Fire and vegetation dynamics: studies from the North American boreal forest, Cambridge University Press, Cambridge. 125 pp.

Keane, R.E.; Ryan, K.C.; Veblen, T.; Allen, C.D.; Logan, J.; Hawkes, B.C. 2002. Cascading Effects of Fire Exclusion in Rocky Mountain Ecosystems– A Literature Review. US Dept. of Agriculture, For. Serv., Rocky Mtn. Res. Sta., Gen. Tech. Rep. RMRS–GTR–91, 24 pp. *www.fs.fed.us/rm/pubs/rmrs_gtr091.html*

Safranyik, L. 1978. Effects of climate and weather on mountain pine beetle populations. Pages 79–86, in: D.L. Kibbee, A.A. Berryman, G.D. Amman, and R.W. Stark, eds. Theory and practice of mountain pine beetle management in lodgepole pine forests. Symp. Proc., Univ. Idaho, Moscow, ID.

Schmidt, K.M.; Menakis, J.P.; Hardy, C.C.; Hann, W.J.; Bunnell, D.L. 2002. Development of coarse-scale spatial data for wildland fire and fuel management, U.S. Dep. Agric. For. Serv. Gen. Tech. rep. RMRS–87. Ogden, UT. *www.fs.fed.us/rm/pubs/rmrs_gtr87.pdf*

Taylor, S.W.; Baxter, G.J.; Hawkes, B.C. 1998. Modeling forest succession on fire behaviour potential in southeastern British Columbia. Pages 2059–2071, in: III International Conference on Forest Fire Research, 14th Conference on Fire and Forest Met., November 16–20, 1998, Luso, Portugal.

Taylor, S.W.; Parminter, J.; Thandi, G. 2005a. Logistic regression models of wildfire probability in British Columbia. Reported submitted to Government of B.C., Forest Investment Account, Forest Science Program, Project Y05–01233, Annual Technical Report Supplement 2, April 30, 2005. 14 pp.
www.for.gov.bc.ca/hfd/library/FIA/2006/FSP_Y062233.pdf

Taylor, S.W.; Thandi, G.; Hawkes, B. 2005b. Interactions between wildfire and forest insect outbreaks in British Columbia. Reported submitted to Forest Science Program, Project Y05–01233, Annual Technical Report Supplement 1, April 30, 2005. 10 pp.
www.for.gov.bc.ca/hfd/library/FIA/2006/FSP_Y062233.pdf

4. Black huckleberry: Importance, biology, and likely response to future conditions and management practices

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Introduction

Huckleberries (*Vaccinium spp.*) are a valuable non-timber forest product. Black huckleberry (*Vaccinium membranaceum*) has significant cultural, economical, and ecological value but little research has been done on this species in British Columbia. It is one of the most important huckleberry species in British Columbia and its distribution is among the broadest . There is serious concern, however, about whether current land-management practices will ensure a sustainable supply of berries. Fire suppression and some current forestry practices (e.g., mechanical site preparation) may have a detrimental effect on berry-producing shrubs (Simonin 2000, Hauessler *et al*. 1990). Furthermore, there is an increasing global demand for huckleberries as a nutraceutical, which may further tax long-term berry supply (Tom Hobby, pers. com. 2006).

Vaccinium membranaceum has a long history of human use by First Nations as well recreational and commercial harvesters. Recent surveys have shown that many First Nations across the province use this resource as an important source of food and income. There is also an active commercial and recreational berry harvest in the interior of British Columbia.

Huckleberries are vital for wildlife, including bears, birds, and small rodents. Particularly important for grizzly bear populations, huckleberries dominate the bear's fall diet and are considered a critical fall food. Grizzly bears in the Flathead area of southeastern British Columbia are known to gain over one kilogram per day eating berries prior to hibernating. Wildlife managers and conservationists are concerned that current land-management practices, coupled with intense human competition, will lead to a shortage of this resource, which could ultimately threaten grizzly populations.

BC Ministry of Forests and Range operational staff and First Nations groups have expressed the need for more specific information on management practices that affect berry productivity because current knowledge of black huckleberry biology and management in British Columbia is limited. Huckleberry response to common forest management practices is largely unstudied.

Management issues include the following:

- The need for compatible management of forests for non-timber forest products and trees
- First Nations' concerns for loss of a staple food source and economic opportunities as well as loss of traditional customs associated with the huckleberry harvest
- The need to maintain and enhance wildlife habitat for species at risk
- Demand for improving harvest yields of black huckleberry for recreational and commercial pickers.

<u>Biology, ecology, and fruit production</u>

Black huckleberry is a low- to medium-sized, deciduous shrub that has extensive rhizomes and sprouts readily. It may take 15 years to reach full maturity and rarely reproduces from seeds. There is considerable ecotypic variability in berry production (Barney 1999).

Huckleberry prefers acidic soils with a pH of 4–5 (range 3.2–6.7) that are moist, well-drained, organic-rich loams. It occurs on cool, frost-prone sites with long winters and requires snow cover on buds from November until April. Night-time temperatures of 4–8°C favour fruit development and drought reduces fruit development because fruit dry up.

Plants do not exhibit cyclic flowering or "mast" years. They are self-unfruitful and require cross pollination. Genetic diversity favours berry production. Seeds lack long-term viability and are poorly represented in the soil seed bank. Poor conditions in the previous year will limit berry production.

Berries are valued for their flavour and are high in Vitamin C, sugars, antioxidants, anthocyanins, phenolics, and flavonols. In the wild, yields range up to 3,000 kg/ha (gal/ac).

Sugar levels increase with elevation. Fruit production is highly dependent upon weather. In the US, bumble bees are reported to be important pollinators. Honey bees "cheat" by drilling into flower bases. Small black flies are thought to be important pollinators in some areas of British Columbia (Barney 1999).

The best sites for berries are moist, montane/ subalpine areas above 800 m on open north-facing slopes (in drier areas). Light shade is preferable on dry sites with other aspects. In wet, cool areas, open, sunny sites are best. Production is limited in heavy shade or in frost pockets.

Climatic factors particularly important for berry production include duration of snow cover, unseasonable temperatures, and drought. If the snowfall is heavy and late-lying there may not be sufficient time for flowering and fruit development. Early season frost, rain, or hail can knock flowers off the plants. Cold snaps after warm temperatures can damage plants. Fruit shrivel up and fall off the plants if there is summer drought. In winters with low snowfall, plants are exposed to freezing damage.

Future: Climate, disturbance, and people

Winter temperatures are predicted to be warmer with more precipitation, which would likely mean increased snowfall at higher elevations of huckleberry range. Warmer winters may reduce chances of early-season frosts and lead to a longer growing season and more berry production. Greater snowfall may lead to later-lying snow, which would reduce plant productivity. Warmer summers with variable precipitation are predicted. Warmer summers may improve plant growth and berry production, provided precipitation is sufficient and does not come as heavy early-season rains. Drier summers could decrease berry production in some areas. Wetter summers might increase berry production in some areas, but heavy early season rains could be detrimental. Warmer summers may lead to more fire, and there is likely to be greater uncertainty and variability in insect outbreaks and disease.

In terms of direct human-caused changes, there is likely to be increased interest in agroforestry, bioproducts, and non-timber forest resources. This may lead to increased berry harvesting for recreational, cultural, and economic reasons and more people in "bear country" competing for berries. Cultivation of black huckleberry in an agricultural or agroforestry setting is likely to occur.

In general, there is likely to be more emphasis on managing for sustainable forests and resiliency of ecosystems. This will likely mean more partial-cutting and smaller clearcuts. In the immediate future, though, forest management will focus on salvaging trees killed by mountain pine beetle.

In mountain pine beetle-affected areas, there is extensive rapid salvage in pine forests, some reforestation, and extensive natural regeneration. There will be increased pressure to log subalpine forests after salvaging is complete in mountain pine beetle-affected forests.

Response to forest management

Logging increases light levels and decreases competition between shrubs and trees in the short term. Berry yields generally increase with increasing light levels and reduced competition. Berry production is good initially in cutblocks, then declines as trees occupy the sites.

Light surface-fires kill above-ground parts and stimulate sprouting. Intense fires can kill rhizomes, and plants recover slowly after burning. It can take 10–15 years to reach full berry productivity after burning. Fire favours huckleberry over other ericaceous subalpine forest shrubs. Historically, berry patches were burned by First Nations in late August or September, just before a rainfall, to enhance berry production. Burns, occurring every 3–5 years, were likely low-impact and targeted in specific areas. Berries were harvested a few years after burning.

Heavy scarification can damage rhizomes and reduce resprouting. Plants are slow to regrow after mechanical cutting and can take over seven years to return to pre-cut levels. Light pruning can promote re-sprouting.

Herbicides kill plants. Removal of other vegetation may enhance huckleberry production.

Summary

- The best berry sites are burnt, open, moist mid-elevation montane/subalpine areas.
- Berry productivity declines as sites become occupied by trees.
- Optimal berry production was 10–15 years after fires in Montana.
- Berry productivity is strongly influenced by weather conditions.
- There is likely to be greater uncertainty in the future regarding climatic conditions and natural disturbances, and this will demand a varied and flexible management approach.
- Future forest management will include considerable salvage activities and increased demand for logging at higher elevations after mountain pine beetle areas are cut.
- Future human-caused effects will include increased human presence in bear habitat and the resulting competition for berries.
- The net effect of all of these changes is a more uncertain future and possibly more early seral stages, which could yield more berries if climate conditions are appropriate.

There is a need to manage forests more conservatively, recognizing uncertainty, i.e., managing for diversity and resiliency.

Management recommendations

- Identify sites with high berry potential.
- Map “berry emphasis” locations.
- Use low-impact slash burns to enhance huckleberry abundance.

- Maintain open or patchy canopies through partial-cutting, patchy or lower stocking, and slower growing trees.

Research needs

More information is needed on:

- factors affecting annual variation in berry production;
- abundance of berries by ecological unit (subzone/site series);
- overstorey/understorey relationships;
- influence of harvesting system, site preparation, and stocking levels on berry production;
- optimal fire frequency and severity; and
- density of berries required for bears.

References

Barney, Danny. 1999. Growing western huckleberries. University of Idaho, Cooperative Extension Program. *http://info.ag.uidaho.edu/Resources/PDFs/BUL0821.pdf*

Haeussler, S. and D. Coates and J. Mather. Autecological characteristics of common plants in British Columbia: a literature review. Can. For. Serv. and B.C. Min. For., Victoria, B.C. FRDA Rep. 158. *http://www.for.gov.bc.ca/hfd/pubs/Docs/Frr/Frr158.htm.*

Simonin,K. 2000 Vaccinium membranaceum. In: Fischer, William C.,compiler. The Fire Effects Information System [Data base]. Missoula, MT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory. *www.fs.fed.us/database/feis/plants/shrub/vacov1*

5. *Polar bears and climate warming*

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Polar bears (*Ursus maritimus*) rapidly evolved from a grizzly bear (*U. arctos*) ancestor to exploit a vacant niche in the Arctic marine environment. As a specialized predator of seals, polar bears have evolved morphological, behavioural, and physiological adaptations to deal with life on the sea ice of the circumpolar Arctic. The annual ice of the Arctic Ocean is the primary habitat of the bears, and it is an ephemeral habitat that shrinks and swells with the seasons. Unlike freshwater ice, sea ice is a dynamic, shifting, and vital part of the marine systems of the north. Winds, currents, and tides move the ice and create a diversity of habitats for a variety of marine organisms. Polar bears are closely tied to these patterns of sea ice drift, formation, and break-up. Without the sea ice, there would be no polar bears. Unlike all other species of large carnivores, the polar bear is unique in that it still occupies virtually all of its historic range. However, because of climate change and the major threat it poses, this is about to change.

The fundamental concern is simple: loss of habitat. Climate warming is particularly advanced and exacerbated at high latitudes. Sea ice cover is decreasing, the thickness of ice is diminishing, and the duration of ice cover is shortening. The net effect is akin to habitat loss for terrestrial bears. Perhaps the loss of sea ice is even more of a concern because there is no hope for habitat restoration or recovery unless climate warming can be stopped.

Long-term studies have shown that polar bears are in trouble. Polar bears have a short window of opportunity to hunt seals and store the blubber of their prey onto their own bodies to use when food is unavailable. Any changes to the sea ice that affect the bear’s hunting success rapidly translates into reduced fat stores. We are already seeing bears in some populations in poorer condition. Bears with lower fat stores have both lower reproductive rates and survival rates. Some populations have declined in abundance between 17 and 22% over the last two decades. Cannibalism, something rarely noted in the past, may be on the increase with adult males preying on younger bears and adult females because normal prey is scarce. Drowning of bears has been noted in Alaska where the sea ice has been dramatically altered. In many populations, the distribution of the bears is changing. This shift in distribution can bring bears into closer contact with humans and lead to more human-bear interactions.

Some species can shift northward or up in elevation to maintain the appropriate temperatures as the climate warms. Unfortunately for polar bears, the Arctic Ocean to the north of their current distribution is a deep, cold, and biologically unproductive part of the world. Even with climate warming, the Arctic Ocean will not replace the productive coastal habitats that the bears currently prefer.

Polar bears, like other bears, are opportunistic, but the ecological niche of an Arctic terrestrial bear is already occupied by the barren-ground grizzly. Polar bears are a marine mammal and rely almost totally on the marine ecosystem. It is wishful thinking to imagine that 400,000 years of evolution could be undone in 50 years or less. The World Conservation Union Species Survival Commission (IUCN/SSC) Polar Bear Specialist listed polar bears as a vulnerable species and felt that a decline of 30% or more was likely to occur within three generations of polar bears. This translates to about 8,000 fewer bears on Earth within 35 years or so.

The signs of change are evident in many Arctic species and the effects of climate warming on polar bears are becoming clearer. The whole ecosystem that polar bears depend upon is changing. Polar bears are a highly specialized species and specialized species are particularly vulnerable to extinction. There is no simple conservation solution. If the climate change scenarios projected by the vast number of climatologists come to pass, the sea ice will disappear and with it, the polar bear will slip away. A relatively new species will be lost to a relatively new problem. Climate stabilization is the only hope for the polar bear.

For more information

Derocher, A.E., Lunn, N.J., and Stirling, I. 2004. Polar bears in a warming climate. Integrative and Comparative Biology 44: 163–176.

Polar bear related links

IUCN/SSC Polar Bear Specialist Group *http://pbsg.npolar.no/*

Polar Bears International *www.polarbearsinternational.org/*

World Wildlife Fund, Canada *www.wwf.ca/*

Homepage for Andrew Derocher *www.biology.ualberta.ca/faculty/andrew_derocher/*

Presentations for the afternoon of October 24, 2006

Session Chair, Dr. Bruce McLellan

6. Recovery of Yellowstone grizzlies–How we got here and why

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This summary is adapted from Dr. Servheen's Power Point presentation.

The Greater Yellowstone Ecosystem is the most well known of the five areas in the lower 48 US states with a grizzly population. For many years, bears in Yellowstone National Park (YNP) were accustomed to eating garbage. Bear management inside YNP has a long history of actually promoting access to garbage for bears, which historically resulted in high numbers of bear/human conflicts:

- 1931–1969—an average of 48 human injuries per year due to bears inside YNP
- 1931–1969—an average of 138 property damage incidents per year due to bears inside YNP

Bear management inside YNP began to change in the late 1960s. In 1968 the National Park Service (NPS) decided that feeding bears garbage was unnatural and should stop. The question was: to make the withdrawal of the practice rapid or gradual? After consultation with the NPS Natural Sciences Advisory Committee, the rapid plan was chosen.

As expected, there were an increased number of both conflicts and dead bears as access to garbage was phased out between 1969–1971. Concern over these deaths stimulated the creation of a state/federal interagency study effort in 1973. However, controversy continued. The initial study effort was revised in 1974, and this became the Interagency Grizzly Bear Study Team.

The grizzly was listed under the US *Endangered Species Act* in 1975, because of the following:

- Overall reduction in range
- Livestock grazing, timbering, and road and trail construction in grizzly habitat
- Indiscriminate illegal killing, excessive control actions related to livestock, and sport hunting that altogether resulted in unsustainable mortality
- Possible impacts of isolation of bear populations
- Rapid closing of garbage dumps in Yellowstone resulting in dispersal of bears out of the park

The Interagency Grizzly Bear Committee

The Interagency Grizzly Bear Committee (IGBC) represents interagency co-operation of organizations with a multitude of mandates. It was created in 1984 by a Memorandum of Understanding (MOU) signed by the two Assistant Secretaries of Interior and Agriculture, and the four Governors of the states of Wyoming, Montana, Idaho, and Washington. It was directed to co-operatively implement the Grizzly Bear Recovery Plan and to "provide for the recovery of the grizzly bear." The overall objectives of the IGBC are to the following:

- Implement the tasks in the Grizzly Bear Recovery Plan
- Conserve and recover the grizzly bear in four US states and adjacent areas of Canada where it still exists
- Manage interagency co-operation to achieve this goal using a co-operative approach emphasizing habitat and mortality management
- Enhance communication and co-operation toward this mutual goal

Members of the IGBC include the following:

- US Forest Service (USFS)
- US Fish and Wildlife Service
- US National Park Service
- State Wildlife Agencies of Montana, Wyoming, Idaho, and Washington
- US Bureau of Land Management
- BC Ministry of Environment, Fish and Wildlife Branch
- Indian Tribes (as Subcommittee members)
- Alberta Wildlife Branch
- Parks Canada

The IGBC made a difference because it committed agencies to a common objective by signatures of high-level officials. It provided an accountability link between the decision makers in the agencies and the implementation of the Recovery Plan, and it provided structure for interagency co-operation.

What happened to allow this population to grow and recover?

Mortality control was implemented, particularly related to bear/human conflicts involving garbage and livestock. Grizzly mortalities within YNP were dramatically reduced from the period when dumps were open and immediately after dump closures.

State management also limited mortality. For example, in Wyoming prior to 1968, there were no restrictions, nor reporting requirements on the killing of grizzly bears

Habitat management was implemented to increase habitat security and to secure attractants. Road closures began (1,000+ miles closed to date). Garbage dumps were closed or secured (e.g., Cook City dump was gated and then closed, West Yellowstone garbage was hauled out of the ecosystem) and campground garbage was secured (e.g., many USFS campgrounds used to have open dumpsters in them that attracted bears at night).

Backcountry sanitation was enhanced (the Parks Service has always been relatively good with backcountry sanitation, but the USFS needed a major effort to improve sanitation in backcountry areas. Therefore, a backcountry food storage order was implemented.)

Outreach began to create partnerships with backcountry users and residents (e.g., outfitter organizations became partners in promoting proper backcountry attractant storage, and West Yellowstone passed an ordinance concerning garbage and attractants storage)

Under the leadership of Dick Knight and then Chuck Schwartz, Yellowstone grizzly bears became the most studied bear population in the world. Examples of publications from 2006 on the science conducted on this population include:

Robison HL, Schwartz CC, Petty JD, Brussard PF. 2006. Assessment of pesticide residues in army cutworm moths (Euxoa auxiliaris) from the Greater Yellowstone Ecosystem and their potential consequences to foraging grizzly bears (*Ursus arctos horribilis*). Chemosphere 64:1704–1712.

Schwartz CC, Gunther K. 2006. Grizzly bear management in Yellowstone National Park: the heart of recovery in the Yellowstone ecosystem. Pages 232–238 in McCullough DR, Kaji K, Yamanaka M, editors. Wildlife in Shiretoko and Yellowstone National Parks: lessons in wildlife conservation from two World Heritage sites. Shiretoko Nature foundation, Hokkaido, Japan.

Schwartz CC, Haroldson MA, Gunther KA, Moody D. 2006. Distribution of grizzly bears in the Greater Yellowstone Ecosystem in 2004. Ursus 17(1):63–66.

Schwartz CC, Haroldson MA, West K, editors. 2006. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2005. Bozeman (MT): U.S. Geological Survey.

Schwartz CC, Haroldson MA, White GC, Harris RB, Cherry S, Keating KA, Moody D, Servheen C. 2006. Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem, Wildlife Monographs 161.

Science and monitoring information was directly translated into management action and intensively applied to the Yellowstone grizzly population and its habitat. This was made possible by the structure of the IGBC with its close connections and feedback from monitoring and research. The interagency IGBC system also provided application of adaptive management. An Adaptive Management plan includes three critical elements:

- Conceptual and quantitative models that make explicit the current understanding of the system, the underlying hypotheses driving management, and key uncertainties
- Rigorous monitoring plans focused on reducing the most critical uncertainties and clearly evaluating progress towards management goals
- A scientifically defensible plan for monitoring and research including rapid action on research results and feedback from management outcomes to revised management decisions

We were fortunate in Yellowstone. We started with 150–200 bears in the population so there were enough females to respond to management action and, as a result, cub production and survival increased. We had a core refuge of secure habitat and approximately 25,000 km^2 of public land that could be managed carefully. We had commitment from managers to make radical changes in management to benefit bear conservation.

Successful bear management requires four things:

- Biological data
- Political support
- Public support
- Organization, knowledge, and people to implement conservation action

The overall objective for recovery was: Assure a healthy and secure grizzly bear population in the Yellowstone ecosystem after recovery and delisting.

Steps to achieving this objective were the following:

- Develop strong and scientifically credible information on monitoring and bear population demographics.
- Develop strong and scientifically credible habitat management that will assure the habitat necessary to maintain a healthy and secure bear population.
- Develop a comprehensive adaptive management plan that all agencies agree to implement upon recovery and delisting.

Population demographics

Ensure population health, demographic management, and monitoring are scientifically sound and conservative, by doing the following:

- Developing multiple population monitoring indices to assure sensitivity of the monitoring system
- Being conservative with all assumptions to minimize overestimation risk
- Developing detailed and conservative limits on mortality to assure that mortality is within sustainable limits
- Using the expertise of the best quantitative experts available in the development and critical review of these demographic management and monitoring systems

Managers need to use strong and scientifically credible information on the status of the population by consulting the International Grizzly Bear Study Team analyses published in the Wildlife Monograph in 2006: *A reconsideration of methods to estimate population size and sustainable mortality rates for grizzly bears in the greater Yellowstone ecosystem.*

Distribution of initial sightings for 118 unduplicated females with cubs identified during 2003–2005:

- 118 represents the minimum number of adult females in the ecosystem in 2005
- 91% were sighted within the recovery zone

Habitat criteria

Within the 25,000 km^2 (9,200 mi^2) recovery zone where 85–90% of the females with cubs live the following criteria are recommended:

- No increase in motorized access without mitigation
- No increase in site developments without mitigation
- No decrease in secure habitat without mitigation
- No increase in livestock allotments
- No decrease in habitat effectiveness

Why delist the Yellowstone grizzly?

The *Endangered Species Act* is an active law. It requires that we: "Get listed species to the point at which protection under the *Act* is no longer required." That is why we are delisting.

Delisting does not mean that management and monitoring will cease or even be reduced. In fact, funding will increase by $1.2 million per year after delisting to assure that the mechanisms remain in place to manage and monitor the population, and to safeguard its future. An interagency management committee will continue to implement the Conservation Strategy, which will be adaptive and feed monitoring results into management responses.

Intensive radio-tracking will continue on 25 adult females. Major foods, disease and insect impacts on major foods, and effects of food changes on reproduction, survival, and bear-human conflicts will be monitored.

Mortality limits will be conservative. Reporting will be conducted by the Study Team and all mortalities will be counted, including human-caused, natural, and the calculated unknown/unreported number of deaths.

What of the future?

Grizzly bears will eventually occupy all of the suitable habitat in the Yellowstone ecosystem including Grand Teton National Park and the Jackson Hole area.

We have come a long way since 1982 and the fear that Yellowstone grizzlies might disappear. The future may not resemble the past, but we know that we must be adaptive and responsive if we are to preserve the treasures we have been entrusted with. Monitoring of foods, vital rates, and bear/human conflicts will continue, and there are triggers for management and status reviews to address problems or to relist the population if necessary. Adaptive management will be in place to feed monitoring and research data into management decisions.

7. Bear viewing at Knight Inlet Lodge

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Knight Inlet is a remote, steep-sided fjord, and the longest fjord on the British Columbia coast. Knight Inlet Lodge is located about 60 km from the mouth of the inlet, and is about 80 km, or 50 air miles, north of Campbell River, British Columbia, The lodge is tucked into Glendale Cove, where the Glendale River empties into the inlet. Huge tidal flats provide superb spring forage; there is lush berry growth in summer and rich salmon runs of Pink and Chum in autumn. Glendale Cove is home to one of the largest concentrations of grizzly bears in British Columbia. It is not uncommon for there to be up to 50 bears within 10 km of the lodge in the peak fall season, when the salmon are returning to the river.

Although bears are abundant in the fall, it is not the only season that grizzly bears can be found in Glendale Cove. Starting in late April, the bears return to the estuary from winter dens and begin the year feeding on the sedges, succulents, grasses, and barnacles that abound in the estuary.

Knight Inlet Lodge can accommodate up to 30 guests. Guest packages can include bear viewing, guided kayak tours, marine wildlife tours, birding, fishing, and rafting. The lodge is an assortment of construction styles dating from the early 1940s, when the original floating lodge housed a logging camp. In the 1970s the lodge was a fishing camp. By the 1990s, sport fishing was on a downward trend, and ecotourism/wildlife viewing was increasing. In 1995, the Wyatt family purchased the lodge and began to offer bear viewing and nature-based activities.

Bear viewing

We view the bears differently in the different seasons. In the spring, we set out in boats so that we can get close to the shore (50 m) and give our guests a good view of the bears feeding. We still remain far enough away so we don’t disturb them. Our early summer program continues on the water as well, but if the opportunity arises there may be a chance to use our tree stands. By mid-August we move to our two platforms at the spawning channel, although we continue to use the tree and river stands. (In 1984, Fisheries and Ocean Canada created a fish spawning channel to rehabilitate the salmon run in the Glendale River.)

In all of our viewing programs the safety of our guests is of utmost importance. We strive to see the bears in their natural environment without having a negative impact on them.

In 1996, 200 people came to see the bears. In 2006, 2,200 people came to see the bears between May and October. Gross revenues in 2006 were $2.8 million. Our payroll is close to $700,000, and most of the 20 staff are local North Islanders.

The 2,200 guests who came to Knight Inlet Lodge in 2006 came from the following areas:

- 65% came from the United Kingdom

- 10% came from the United States
- 10% came from Australia
- 10% came from Holland

Managing bear viewing is more about managing people than managing bears. A strict set of protocols are followed. We keep our activity patterns predictable and leave sufficient feeding time and space for bears that wish to avoid people.

We run a research program, which includes: bear viewing sustainability/ bear-human interaction; bioenergetics and behaviour; salmonid enhancement in co-operation with Fisheries and Oceans Canada; and use of telemetry to investigate home ranges of our bears.

In our viewing area, we found that large male grizzlies avoid using the channel when people are present, and we see refuging by females with cubs. They consume 37% more fish when people are present. Females drop vigilance behaviours and spend more time fishing.

We are proud and active supporters of the BC Wilderness Tourism Association (*www.wilderness-tourism.bc.ca*).The Wilderness Tourism Association is an industry association of nature-based tourism businesses who work co-operatively to ensure a sustainable industry.

Knight Inlet Lodge is a founding member of the Commercial Bear Viewing Association of BC (CBVA) (*www.bearviewing.ca*). In British Columbia, total direct bear viewing brings revenues of $6.1 million annually (versus $3.3 million for grizzly trophy hunting). The CBVA fosters sustainable, ethical viewing practices, and guide training. The Association has taken a stand against trophy hunting of grizzly bears in British Columbia.

Guide Training includes the following:

- CBVA Endorsed Guide Training Course
- Bear ecology/physiology (Grant MacHutchon)
- Nature interpretation
- Advanced Wilderness First Aid
- Other modules (e.g., kayaking, VHF Radio etc.)
- Certification

Bear viewing has become politicized. There are many agencies with an interest in bear viewing:

- First Nations
- Other resource users, BC Ministry of Forests and Range
- Aquaculture, Fisheries and Oceans Canada
- BC Ministry of Tourism
- BC Ministry of Environment
- General public
- Other commercial recreation businesses
- Trophy hunters

- Environmental and industry groups

For more information about Knight Inlet Lodge, visit:

www.grizzlytours.com

8. Changes in human attitudes towards bears

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Emily's thesis is available on-line:

Chamberlain, E.C. (2006). Perspectives on grizzly bear management in Banff National Park and the Bow River Watershed, Alberta: A Q Methodology Study. M.R.M. research project no. 394, School of Resource and Environmental Management. Burnaby, B.C.: Simon Fraser University. Available online: *www.rem.sfu.ca/pdf/Chamberlain%20MRM%20Project.pdf*

This summary highlights how successful grizzly bear conservation requires not only biophysical knowledge, but also an understanding of the human factors that shape decision making about bears. Human attitudes and values towards bears are often studied to understand, and potentially change, people's behaviour. This is especially important because in many settings humans are the primary cause of bear mortality.

Values, attitudes, and behaviour: A conceptual framework

In order to understand human behaviour regarding the environment, some scholars use a conceptual framework in which an individual's relationship with their environment is organized into a cognitive hierarchy of values, attitudes, and behaviours (e.g., Fulton *et al*. 1996, Homer and Kahle 1988). Values are enduring beliefs that a mode of conduct or end-state of existence is preferable (Rokeach 1973); they are few in number, relatively stable, and are the foundation for attitudes and behaviours. Values are more general than attitudes, which allow humans to evaluate an object or situation that is relatively persistent (Manfredo *et al*. 2004). These attitudes, in turn, influence people's behaviour.

Fulton *et al.* (1996) suggest that value orientations (or basic beliefs) are an additional component of the value–attitude–behaviour hierarchy. Value orientations are clusters of interrelated values; for example, wildlife value orientations are a pattern and direction of beliefs regarding wildlife (Fulton *et al*, 1996). Value orientations strengthen and give meaning to more general values, and are a foundation for attitudes and behaviours.

<u>Changes in attitudes toward bears</u>

There are few studies that demonstrate trends in attitudes and values towards wildlife due to the relatively recent study of these concepts in natural resources research (Manfredo *et al.*, 2004). Much of the empirical research on wildlife values has emphasized the multiple dimensions of values and has focused on typologies of values toward wildlife. For example, Teel *et al.* (2005) found that wildlife-value orientations among the public in the western United States can be characterized along a utilitarian-mutualism continuum. Utilitarians believe that wildlife is primarily for human use, and are strongly supportive of hunting, whereas mutualists believe that wildlife is part of an extended family that includes humans. Some individuals hold both utilitarian and mutualist value orientations (pluralists), while others hold neither (distanced). States with populations that are urbanized, and that have a high income and a high education, tend to have a greater proportion of people with mutualist values. Generally, there has been a shift in societal values over the latter half of the twentieth century away from orientations that emphasize the use and management of wildlife for human benefit. Teel *et al.* (2005) found that that these shifts have been driven by increasing affluence, education, and urbanization among the public.

Kellert (1994) identifies eight types of values concerning wildlife: naturalistic, ecologistic, humanistic, aesthetic, scientistic, utilitarian, dominionistic, and negativistic. His research indicates that generally there has been a shift from a utilitarian/dominionistic view to ecologistic and scientistic values. These values also vary among demographic groups. For example, people dependent on land and natural resources (i.e., rural residency, resource-dependent occupations) tend to hold utilitarian and dominionistic views. College-educated, urbanized individuals with a higher income, as well as females, are more likely to value wildlife for their ecological connections.

Kellert (1994) found that attitudes toward bears are also influenced by people's perception of the individual species (e.g., phylogenetic relation, presumed intelligence, and threat), and their personal interactions with bears. Knowledge and understanding of bears also influences peoples' attitudes; however, attitudes are not easily shifted by increased factual knowledge alone. People may use knowledge to rationalize and reinforce existing values instead of to change them (Kellert *et al.*1996).

<u>Case study: Perspectives in the Banff–Bow Valley</u>

I studied beliefs about grizzly bear management in Banff National Park and the Bow River Watershed of Alberta (Chamberlain 2006). The study focused on beliefs and attitudes about bear management rather than human values, although values clearly influence these beliefs. Q methodology was used to explore the perspectives of participants about the problems with grizzly bear management and potential solutions to those problems. Q is a social science method in which participants map their perspectives by sorting statements about a subject of interest. Research was completed from May–September, 2004.

I found four main perspectives on the problems with grizzly bear management in the region. Views on the status of the bear population, and on the factors that contributed to the population status, were divergent.

- Perspective 1 was concerned about the status of the bear population, and believed that poor human-use management and the lack of an overall conservation strategy had contributed to this status.
- Perspective 2 had a fundamentally opposite view of the problems than Perspective 1. This group believed that the bear population was healthy, that successes were not recognized, and that problems were overemphasized, in part by interest groups with other agendas. Perspective 2 also believed that human-use management had been successful.
- Perspective 3 shared Perspective 1's concerns about the status of the population and human use. This group was different, however, in that they believed that management was fragmented between agencies and was hampered by inconsistent techniques used to manage bears as well as insufficient funding for management.
- Perspective 4 believed that the population status was acceptable, and that problems were overemphasized, but this group was distinct from the other perspectives in their strong rejection of statements that identified funding as a problem, suggesting they felt that funding for bear management was adequate.

All perspectives agreed that the population was vulnerable, but also the healthiest it had been in 25 years. There was also common support for the belief that the park was not at carrying capacity and could support more bears, but there was also concern about increased bear–human conflict in the future. Finally, there was agreement that achievements in bear management haven't been adequately celebrated.

I found three main perspectives on the solutions to the problems of grizzly bear management in the Banff–Bow Valley.

- Perspective A recommended prioritizing conservation both in Banff National Park and adjacent regions, and limiting human use and development.
- Perspective B rejected these solutions, in part because they believed that human use was already restricted in the areas most important for bears and further restrictions weren't necessary. This group also most strongly supported using science to guide management.
- Both perspectives A and B supported increased collaboration between Parks Canada, provincial agencies, and third-party interests.
- Perspective C recommended actively managing bear habitat, through increasing habitat in backcountry areas, and reducing habitat near communities to keep bears and people separate. As well, they supported the idea that when a recreation area is closed to human use for bear conservation, that a new recreation area should be opened. This group also strongly supported changing bear research methods in the region, including minimal collaring and drugging of bears.
- Perspectives A, B, and C all supported designing human use around ecological constraints, and building an appreciation for bears among recreational users. As well, these groups supported more effectively including interests in decision making.

Participatory strategies for bear conservation

As shown by this study in the Banff–Bow Valley, people have widely different beliefs about bear conservation. Although there has been extensive scientific research on the bear population through the Eastern Slopes Grizzly Bear Project (Herrero 2005), perceptions about the status of the bear population and the factors that contribute to this status vary. Since a "problem" is a subjective discrepancy between "what is" and "what ought to be," problems are defined by people based on their values and beliefs (Dery 1984). Different definitions of the problems of bear conservation often lead to conflict between individuals over appropriate management measures. This is complicated by the fact that bears are often symbolic of larger issues, and the debate over bears may actually be a debate about fundamental issues such as wilderness protection, park use, or appropriate ways of making public decisions (Primm and Murray 2005).

One approach to reducing conflicts over bear conservation is to use localized participatory strategies to improve the decision-making process associated with bear conservation. Participatory strategies involve "local participants working together on real, manageable, on-the-ground problems in which power and control are not such major issues and symbolic debate is minimized" (McLaughlin *et al.* 2005, p. 189). McLaughlin *et al.* (2005) recommend a process of moving from engagement, which focuses on building trust and relationships among participants, to collaboration, which emphasizes consensus building, to formalization, in which the program is institutionalized. A benefit to participatory strategies is that they are more likely to generate solutions that have public support than those programs without local input. Many solutions for successful bear conservation will require the support of participants who live in bear habitat.

The Q study described above was followed by a series of three multi-stakeholder Interdisciplinary Problem-Solving workshops in the Banff–Bow Valley. These workshops involved a number of participants involved in the Q study, as well as other stakeholders in the region. The workshops focused on improving understanding of participants' values and of the beliefs and the values of others, and on developing a common understanding of the problems and alternatives for social process, decision process, and bear and habitat issues in the region. After the third workshop, a working sub-group developed an interim and ongoing management plan for a region in Banff National Park that had a number of bear-human conflicts. These problem-solving workshops have helped participants to move away from simply arguing over biological trends such as the status of the bear population, and to focus on reducing actual conflicts with bears. In doing so, they are altering decision-making processes to be more democratic and inclusive, and to take into account diverse values.

References

Chamberlain, E.C. (2006). Perspectives on grizzly bear management in Banff National Park and the Bow River Watershed, Alberta: A Q Methodology Study. M.R.M. research project no. 394, School of Resource and Environmental Management. Burnaby, B.C.: Simon Fraser University. Available online: *www.rem.sfu.ca/pdf/Chamberlain%20MRM%20Project.pdf*

Dery, D. (1984). Problem definition in policy analysis. Lawrence, Kansas: University Press of Kansas.

Fulton, D.C., M.J. Manfredo, & J. Lipscomb. (1996). Wildlife value orientations: a conceptual and measurement approach. Human Dimensions of Wildlife 1(2): 24–47.

Kellert, S. R. (1994). Public attitudes toward bears and their conservation. International Conference of Bear Research and Management, 9, 43–50.

Kellert, S. R., Black, M., Rush, C. R., & Bath, A. J. (1996). Human culture and large carnivore conservation in North America. Conservation Biology, 10(4), 977–990.

Herrero, S. (Ed.), (2005). Biology, demography, ecology and management of grizzly bears in and around Banff National Park and Kananaskis Country: The final report of the Eastern Slopes Grizzly Bear Project. Calgary, Alberta: Faculty of Environmental Design, University of Calgary.

Homer, P.M. & Kahle, L.R. (1988). A structural equation test of the value-attitude-behavior hierarchy. Journal of Personality and Social Psychology, 54, 638–646.

Manfredo, M.J., Teel, T.L. & Bright, A.D. (2004). Application of the concepts of values and attitudes in human dimensions of natural resources research. In M.J. Manfredo, J.J. Vaske, B.L. Bruyere, D.R. Field, & P.J. Brown (Eds.), Society and natural resources: A summary of knowledge. Prepared for the 10th International Symposium on Society and Resource Management (pp. 271–282). Jefferson, Missouri: Modern Litho.

McLaughlin, G. P., Primm, S., & Rutherford, M. B. (2005). Participatory projects for coexistence: Rebuilding civil society. In T. W. Clark, M. B. Rutherford & D. Casey (Eds.), Coexisting with large carnivores: Lessons from Greater Yellowstone (pp. 177–210). Washington, D.C.: Island Press.

Primm, S., & Murray, K. (2005). Grizzly bear recovery: Living with success? In T. W. Clark, M. B. Rutherford & D. Casey (Eds.), Coexisting with large carnivores: Lessons from Greater Yellowstone (pp. 99–137). Washington, D.C.: Island Press.

Rokeach, M. (1973). The nature of human values. New York: Free Press.

Teel, T. L., Dayer, A. A., Manfredo, M. J., & Bright, A. D. (2005). Regional results from the research project entitled “Wildlife Values in the West.” (Project Rep. No. 58). Project Report for the Western Association of Fish and Wildlife Agencies. Fort Collins, CO: Colorado State University, Human Dimensions in Natural Resources Unit.

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9. The future of bear hunting

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Whether or not bear hunting has a future is a matter of opinion and is not subject to the usual evidentiary constraints that apply to science. Correspondingly, my comments should be understood as opinions.

Biologically, bear populations, like any population of animals, can sustain a properly managed harvest indefinitely as long as the population is not declining from other causes, and the habitat remains intact and populations are interconnected. The problem facing bear hunting is that in too many areas in southern Canada and in the lower 48 US states, these habitat conditions do not occur. In these areas, bear hunting does not have much of a future unless it can be highly focused on male bears. Fortunately, management techniques exist that can focus hunting largely on males, and to the degree these are adopted, harvests on even isolated populations will have little population-level effect. Males are largely inconsequential to population growth and expansion.

Habitat deterioration is certainly the greatest threat to the future of bear hunting. As habitats deteriorate, bear populations will decline and sustainable harvests will decline at the same rate. Hunters and environmentalists share an interest, therefore, in the preservation of habitat and environmentalists should get over their personal distaste for bear hunting and join forces with hunters on habitat preservation, including the creation of reserve populations where hunting does not occur. Similarly, hunters need to accept that some hunting practices contribute to the environmental groups' distaste for hunting and should reform these practices. Recovery of small depleted populations is expensive and politically difficult, so hunters and environmentalists should unite to preserve the habitat of the remaining large and contiguous brown bear populations.

Hunters need to acknowledge that there are great economic benefits associated with "existence values" and viewing of bear populations. The "Total Social Benefit" (TSB) is the economic value of an individual hunting or primary purpose viewing trip on which the number of bears seen is multiplied by the total number of trips. Data from Alaskan studies indicate that the TSB from hunting of both black and brown bears by resident hunters is \$4.15 million (1991 US\$) and hunting by non-resident bear hunters is \$17.05 million. In contrast, bear viewing by Alaskan residents had an estimated TSB of \$29.11 million. Bear viewing by non-resident visitors had an approximate TSB of \$196.39 million (this number was derived in a way that was somewhat incompatible with the other TSB numbers).

Bear viewing and hunting are not mutually exclusive activities across broad geographic areas, but are probably incompatible in some small areas. Hunters should not insist on hunting in areas where bear viewing is developed and popular. For example, bear hunters in Alaska are making a mistake by insisting on hunting in close proximity to the McNeil River State Game Sanctuary.

The following section includes points taken from Dr. Miller's Power Point presentation.

The future of bear hunting: Some thoughts and opinions to stimulate discussion

Some basic truths:

- Bear populations can sustain a human harvest.
- Historical declines in bear numbers and distribution were not a result of sport hunting.
- Declines were caused by habitat destruction, and antipathy for bears as economically and personally dangerous.
- Habitat destruction and antipathy are still barriers for maintenance of healthy bear populations (especially brown bears).
- Brown bears are more vulnerable to overhunting than black bears.
- Black bear populations are in better shape now than 100 years ago.
- Brown bear populations are recovering in two areas (Greater Yellowstone Ecosystem and Northern Continental Divide Ecosystem) from historic lows; recovery is possible.
- No brown bear populations have gone extinct in several decades; however, populations in Cabinet Mountain/Yaak/Purcells and North Cascades are close to extinction and are highly endangered.
- Recovery is very expensive and difficult compared to maintenance of healthy populations.
- Management efforts should concentrate on maintenance of healthy populations rather than recovery of depleted ones.
- There is significant culturally based opposition to bear hunting (New Jersey example).
- There is also opposition to certain bear-hunting techniques.
- Opposition sometimes has sound foundation (e.g., hunting small isolated populations).
- Opposition sometimes masquerades as being biologically based (British Columbia example).
- Regardless, in a democracy this opposition is an increasingly effective voice (Alaska excepted), and can't be ignored.
- Hunters ignore this opposition at their peril.

Some economic truths:

- Bear habitats are sensitive to disturbance and fragmentation, such as logging and logging roads, oil and gas development, urbanization, and recreation area development
- This pits maintenance of bear habitats against powerful economic and political interests.
- Declines in bear numbers from this kind of habitat destruction and disturbance reduces the amount of harvest that can safely be taken by hunters.
- Hunters (especially outfitters) are reluctant to accept necessary reductions in harvest quotas.

Some pertinent considerations:

- Some public interest groups get important economic support from individuals opposed to hunting.
- Hunter fees support state and provincial wildlife management agencies.
- Reflecting their funding sources, actions by agencies and some public interest groups are often embedded within a hunting or anti-hunting context.
- Too frequently this pits advocates for bear conservation (non-government organizations and agency biologist staff) against each other.
- This doesn't help conservation efforts.
- Some hunters are their own worst enemies.
- Regardless, hunters and public interest groups should work to find common ground. It's not far away.

Characteristics that make bear populations vulnerable to overhunting:

- Low "r-strategy" (thus, low sustainable harvest rate)
- Highly variable, but typically low population densities
- Same habitats with different densities
- Census techniques are difficult, imprecise, and expensive
- Source-sink dynamics (non-homogenous distribution of hunter and other mortality)
- Unknown/unreported and poaching mortalities (bear parts have commercial value)
- Dispersal by females is slow
- Some hunting techniques effective (e.g., baiting, dogs, and guided hunting)
- Macho factor.

Characteristics that mitigate vulnerability to hunting:

- Bears are habitat generalists and omnivorous.
- Management can focus most of the hunt away from adult females.
- Males are more vulnerable (larger home ranges) and attractive (as trophies) than females.
- Male-based harvests have relatively little effect on population productivity (bears are polygamous).
- Density dependence: hunted populations are more productive than non-hunted ones.
- Sub-adults are unattractive trophies (recruitment).
- Hunters have little interest in hunting for bear meat.
- Short seasons: bears hibernate all winter, summer hides are of little interest to hunters.
- Values: there are culturally distasteful aspects to bear hunting.
- Motives are usually trophy based.
- Alaskan survey: only 14% of non-resident visitors, 22% of voters, and 50% of hunters supported trophy hunting (generic).
- Some hunting methods and means are distasteful.

- There is a teddy-bear sentimentality towards bears.
- Bear hunting is considered as predator management in some areas ((e.g., Alaska).

Future of bear hunting

- Black bear hunting will probably persist widely.
- Brown bear hunting in southern Canada and in the lower 48 states will be non-existent or minimal in the future.
- We should probably not hunt “small” isolated populations of brown bears. Hunters should concede this.
- Brown bear hunting will probably persist in areas where the habitat is intact and not fragmented, where populations are “large” and connected, and where harvests select against adult females.
- It is worthwhile trying to develop approaches to target “problem” bears for removal by hunters.
- Public interest groups need to recognize that habitat, not hunting, should be their focus.
- Bear hunters and hunting are on the defensive and should recognize this and clean up their acts as much as possible.

Further reading

Miller, S.D. 1993. Brown Bears in Alaska: A statewide management overview. Wildlife Tech. Bull. 11, Alas. Dep. Fish and Game, Anchorage. 40 pp.

Miller, S.M., S.D. Miller, and D.W. McCollum. 1998. Attitudes toward and relative value of Alaskan brown and black bears to resident voters, resident hunters, and non-resident hunters. Ursus 10:357-376.

Presentations for the morning of October 25, 2006

Session Chair, Dr. John Woods

10. Provisions for grizzly bear management in regional and forest management plans—Are they working?

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No summary provided.

11. Changing silvicultural practices: Identification and buffering of important habitat features

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Avalanche chutes are an important component of spring grizzly bear habitat and thus have been afforded protection under regional land-use plans. Chutes are important to grizzly bears because they support a diversity and abundance of high-quality bear forage (Ramcharita 2000). Avalanche chutes sustain this level of productivity because they contain moist, nutrient-rich soils resulting from periodic inputs of water, soils, and other organic material from higher elevations (Korol 1994). Furthermore, periodic disturbances of snow avalanches serve to maintain early-seral conditions (Erschbamer 1989), which produce greater amounts of preferred forage (Thomas 1979). Also, portions of chutes are snow-free sooner in spring because of steep slopes and open canopies. Both of these factors result in higher solar radiation, which increases productivity and accelerates snowmelt. These characteristics result in an earlier growing season relative to other habitats, thereby facilitating access to vegetation at a time when grizzly bears are recovering from hibernation. Many of these effects are intensified on south-facing chutes, which correspondingly receive the highest use by grizzly bears in spring (Ramcharita 2000).

The primary means of protecting chutes has been to retain adjacent forest buffers to reduce the potential impacts of nearby forest management activities. We set out to determine the effectiveness of these buffers in maintaining the use of avalanche chutes by grizzly bears. Specifically, we quantified the relationship between buffer width and bear use, while accounting for other factors that may affect the level of bear use such as forb content and other physical attributes. We did a retrospective analysis on a data set centered on Golden, BC, using VHF (Very High Frequency, “telemetry”) data from 60 grizzly bears. We mapped a sample of avalanche chutes (731) and quantified the amount of forb, shrub, tree, and non-vegetated cover within each chute. We also measured forested buffer width on each side of the chute, solar radiation, chute size, chute density (# chutes per km), and quantified the amount of logging adjacent to the chutes. Each chute was the sample unit, and the intensity of use by bears was the response metric. We found that natural biophysical factors were the strongest factors predicting the level of chute use. The density of large chutes (>100 m wide), chute size, forb content, and solar radiation were all positively associated with chute use by bears. Larger chutes tend to have well-developed forb communities, and more of these chutes per unit area provide increased forage opportunities. Snow melts sooner in chutes with higher levels of solar radiation, thereby lengthening the growing season. Forested buffer width or the amount of logging was not a strong factor predicting the level of bear chute use..

References

Erschbamer B. (1989). Vegetation on Avalanche Paths in the Alps Austria. Vegetatio 80(2):139–146.

Korol J.J. (1994). Classification of avalanche paths in Northwestern Montana [Ph.D.]. Missoula: University of Montana.

Ramcharita R. (2000). Grizzly bear use of avalanche chutes in the Columbia Mountains, British Columbia [M.Sc.]. Vancouver: University of British Columbia. 40 p.

Thomas J.W. (1979). Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington: U.S. Department of Agriculture, Forest Service, Agriculture Handbook 553.

12. Fragmentation of grizzly populations: Causes, implications, and solutions

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Mark Boyce, University of Alberta

Recent research has demonstrated that population fragmentation of grizzly bears in southern Canada is being mediated by human settlement, human-caused mortality, and highway corridors (Proctor 2003, Proctor *et al.* 2005). This fragmentation has resulted in several trans-border populations in the south Selkirk and Purcell Mountains shared between Canada and the US that are small, isolated, and threatened (Figure 1). The south Purcell Mountain population is estimated to contain less than 50 animals (M. Proctor unpublished data) and is declining at approximately 3% annually (Wakkinen and Kasworm 2004). The south Selkirk population is estimated to contain less than 100 animals (M. Proctor unpublished data) and is slightly increasing (Wakkinen and Kasworm 2004). Research and simulations have indicated that by reducing human-caused mortality, and improving bear inter-population linkage and habitat security, we can improve the conservation status of these populations in the long term (Proctor *et al*. 2004). Here we report on efforts to improve the bear inter-population linkage, a component of our larger plan to recover these two populations.

BC Highway 3, a major transportation and human settlement corridor, fragments the south Purcell–Yaak grizzly bear population (Proctor *et al*. 2005). Because bears are relatively sparse in this location, and sample sizes consequently low, we used two complementary methods—ecological modelling from hair-snag DNA surveys (Apps *et al.* 2004) and Global Positioning Systems (GPS) radio telemetry—to identify "linkage zones" across Highway 3, which will facilitate the improvement of natural inter-population exchange of animals with adjacent populations. We genetically sampled wild brown bears at 170 hair-snag sites on both sides of the human corridor between 2001 and 2005. Hair follicles were used as a source of DNA to develop microsatellite genotypes that identified 65 different bears at 54 sites, totalling 124 capture events. We then characterized the landscape for 24 ecological and human variables (e.g., terrain ruggedness, riparian areas, forest cover, alpine areas, roads, and settlements). We correlated these variables to bear presence or absence in a multiple logistic regression, and used Geographic Information Systems (GIS) to develop a spatially-explicit "resource selection function" model to predict bear occurrence across our 9,500 km^2 study area. We used the model to predict areas of high use (core habitat) and linkage habitat that connects core areas. We also put GPS radio collars on 11 brown bears that were captured adjacent to the human corridor. The radio collars acquired hourly locations throughout the non-denning seasons. These data revealed the presence of areas where male bears crossed the human corridor and corroborated our predictive model.

Future work will implement management actions that aspire to minimize displacement and mortality caused by human activity within these linkage zones, ultimately enhancing inter-population movement for this fragmented population.

It is challenging to obtain reliable and objective results in a system with few bears, but we reached our goal of identifying linkage and core habitat because we used both DNA-based ecological modelling and GPS radio telemetry methods. Neither method on its own was sufficient, but each contributed significant information to our ecological understanding of the system and provided independent validation of our conclusions. These methods may be useful for studying other sparse bear populations around the world where conservation solutions are required, but low bear numbers make research challenging.

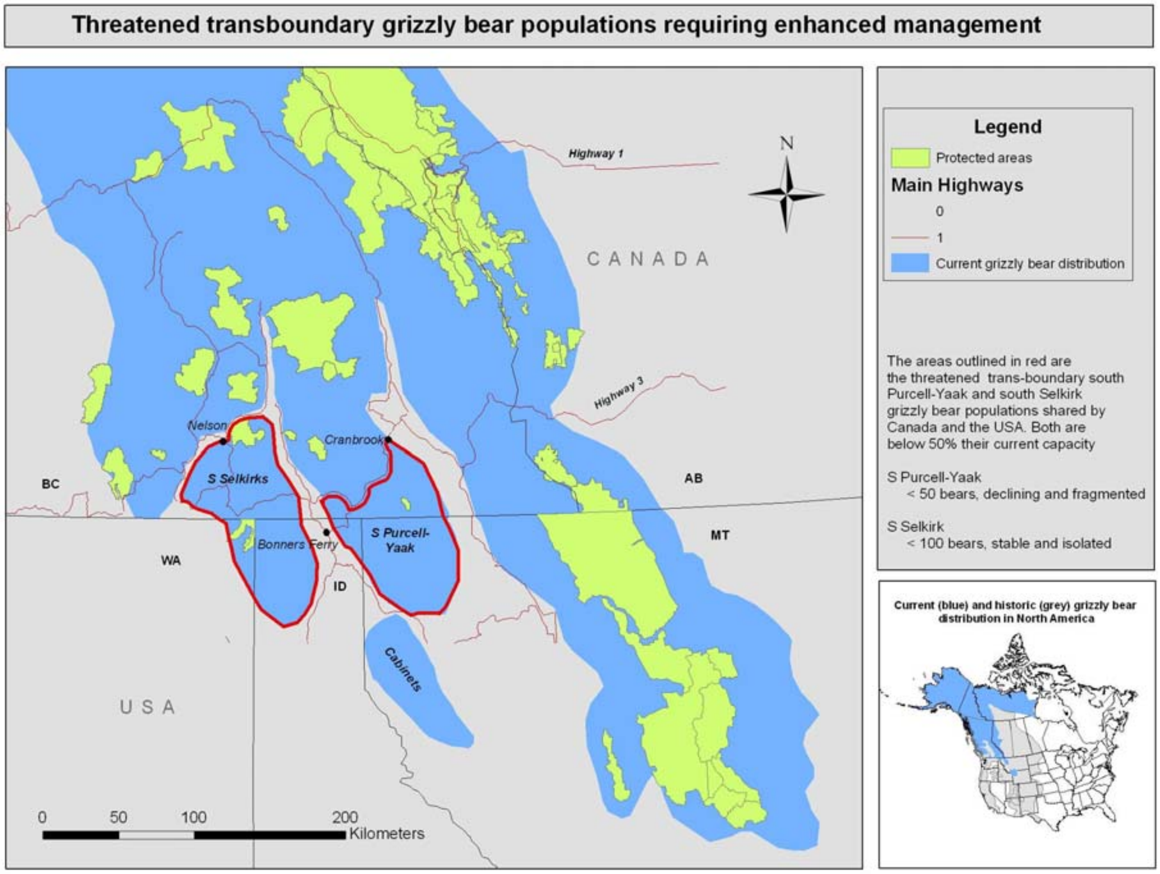

Figure 1. Map of the threatened trans-border south Selkirk and south Purcell–Yaak grizzly bear populations (outlined in red) within the remnant peninsular occupied range in western North America.

References

Apps, C.D., B.N. McLellan, J.G. Woods, and M. Proctor. 2004. Distribution of a grizzly bear population relative to habitat and human influence in southeastern British Columbia. Journal of Wildlife Management. 68:138-152.

Proctor, M.F. 2003. Genetic analysis of movement, dispersal and population fragmentation of grizzly bears in southwestern Canada. PhD Thesis. University of Calgary. 147 pp.

Proctor, M.F., C. Servheen, S. Miller, W. Kasworm, and W. Wakkinen. 2004 A comparative analysis of management options for grizzly bear conservation in the U.S.-Canada trans-border area. Ursus 15:145-160.

Proctor, M., B.N. McLellan, C. Strobeck, and R. Barclay. 2005. Genetic analysis reveals demographic fragmentation of grizzly bears yielding vulnerably small populations. Proceedings of the Royal Society, London. 272:2409-2416.

13. The modern researcher's toolkit: Technological advancements and the changing face of research and monitoring

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Introduction

Technological advancements have dramatically changed the nature of bear research over the past decade or so. We present a cursory review of three major technologies and their application in the study of bear and other large mammal ecology: 1) Geographic Information Systems (GIS) and remote sensing; 2) global positioning systems (GPS); and 3) remote hair-snag sampling and genetic analyses. We discuss how the technology has influenced the research questions we ask, and how our answers are now more directly relevant to bear management and conservation.

GIS and remote sensing

GIS and remote sensing technologies have impacted research by allowing us to easily build, work with, and manipulate large spatial databases (both raster- and vector-based). From these, we can derive and model ecologically relevant factors, as well as specify and explicitly consider spatial scale in our designs and analyses. With the use of GIS and associated spatial databases, increasingly sophisticated methods (empirical and expert-based) have evolved to develop spatially-predictive models. However, with the technology comes the potential for misuse involving inappropriate extrapolation of measured relationships in space, time, and scale. Moreover, in GIS-based analyses, we must often rely on "surrogate" variables that may, at best, only indirectly capture the ecological factors to which bears are responding. This can limit the extrapolation potential of resulting predictive tools.

Global Positioning Systems

Global Positioning System (GPS) technology has given us the capability for relatively accurate positional referencing of both researchers and their study animals. Accuracy of less than 15 m can be readily achieved, although a small percentage of fixes can be highly inaccurate. The virtual lack of geographic or temporal bias is a major advantage over previous Very High Frequency (VHF)-telemetry systems. However, it is well recognized that fix quality and success are influenced by habitat conditions—particularly forest overstorey and topography. Still, options are available to researchers to evaluate and correct for such biases either in their datasets or analyses. Data logging and storage capability of receivers is another valuable aspect of this technology.

Over the past decade, numerous telemetry companies have integrated GPS technology with tracking systems for large mammals. As with any emerging technology, there have been frustrations, but GPS collars have become more reliable in general and undoubtedly will continue to improve. Collar specifications and capabilities vary among manufacturers, but several general features are relevant to bear researchers. First, collars can allow variable and programmable fix-attempt and VHF-beacon schedules, maximizing battery life. Second, collars can independently monitor and log activity data (collar movement on two axes), from which hibernation can also be inferred and in response to which the collar may be programmed to cease fix attempts. Collar temperature is also typically logged. Third, batteries generally may be capable of functioning over two field seasons with 12–24 fix-attempts per day, although fix success may decline over time. Collars can be fitted with remote timer- or radio-triggered drop-off mechanisms. However, these have not functioned with great consistency in the field and researchers typically modify collars to include rot-off spacers. The best fix-success is generally 80–85% but can be substantially lower. The rate of missed or poor quality fixes may relate to environmental factors, such as habitat and related bear behaviour, or atmospheric conditions, but may also be influenced by battery capacity and components of the GPS receiver. Changes in satellite geometry over a 24-hour period may also play a minor role in fix success, as may geographic latitude.

Several design issues are relevant in the application of GPS collars to bear research. These include collar weight and the distribution of weight (models typically used with bears generally weigh between 0.75 and 1.5 kg). Belting material should be durable but light and flexible, and flexibility may be compromised by radio-triggered drop-offs. Antennae should be secure, durable, and not protruding; otherwise damage and collar failure may result. Options for remote data-downloading are generally desired, and should be easy and flexible, while preventing potential data gaps. The considerably faster transmission that is achieved by UHF (Ultra High Frequency) versus VHF systems is highly advantageous when downloading from aircraft. "On demand" collar-communication that facilitates downloading at any time has also been an important cost and labour-saving advancement. More recently, several manufacturers have produced collar models that can transmit data to researchers on a daily basis via communication satellites such as the *Argos* system. Although this option provides many potential advantages and opportunities to researchers, there are limitations relative to conventional download retrieval, details of which should be obtained from manufacturers.

GPS collars are in use by many, if not most, bear researchers in North America today, and have resulted in much different sampling approaches than typical in the days of VHF telemetry. Current sampling designs are influenced by the high per-unit cost (~$5,000–$10,000) of GPS collars, relatively high power consumption, battery limitations of both GPS-engines and collar-release mechanisms, and much steeper failure rate over time in the field. As a result, researchers are tempted to 1) sacrifice animal-sample size and representation across years, 2) choose intensive, shorter duration over longer-term sampling, and 3) attempt more frequent recapture of study animals.

DNA/hair-snag methods

In response to advancements in genetic analysis that allow the amplification of DNA from minute tissue and cell samples, bear researchers developed methods to remotely "snag" hair from bears over extensive sampling areas. Subsequent analyses facilitate the identification of species, sex, and individual, and can characterize gene flow and relatedness among individuals.

Methods and designs have been developed specific to "population level" sampling that is representative of local conditions and meets the assumptions of both mark-recapture population estimation and analysis of spatial distribution potential. Designs typically involve a sampling grid to control the scale and distribution of effort, with cell sizes ranging from 25–100 km^2. Within each cell, a single-strand barbed wire "corral" is created, within which a liquid lure bait is applied that is assumed to attract, but not reward, bears. The technique was first applied in the West Slopes bear study from 1996–98 (Woods *et al.* 1999). Hair samples are collected and stations re-lured at the end of each sampling session, and there may be several (typically 4–5) sampling sessions within a survey. Most DNA lab work for bears is now conducted by Wildlife Genetics International under the supervision of Dr. David Paetkau. Through subsequent analyses, samples and resulting data have been used to evaluate:

- absolute abundance,
- population connectivity,
- spatial distribution and influential factors,
- landscape partitioning between black and grizzly bears, and
- stable isotope signatures allowing discrimination of major food types within diet.

Implications of the technologies

We see several important implications of the above technologies to current and future research and monitoring. First, GIS and remote sensing, GPS, and DNA are collectively allowing us to appropriately match research designs and associated sampling to specific ecological and management scales. That is, questions of population abundance, distribution, and connectivity are best addressed with DNA/hair-snag sampling designs. Finer-scale questions of habitat and movement route selection that do not require population representation are best addressed by selective use of GPS collars. GIS, remotely sensed imagery, and spatial databases are allowing us to represent influential spatial covariates at specific scales of analysis (except perhaps micro-habitat selection). Even within ecological scales, multi-scale analysis designs can be applied that allow us to better understand and describe how habitat and human factors influence bear ecology and conservation.

A second important collective implication of the technologies to the way we do research involves our ability to conduct descriptive modelling across the range of conditions that are relevant to a given management issue. In the past, the conditions encompassed within a study area rarely characterized the range over which management inference was needed, thus requiring a degree of extrapolation that researchers have not always been comfortable with. This issue is less relevant today due to the advancements discussed. That is, DNA/hair-snagging allows us to cost-effectively sample population abundance, distribution, and connectivity across entire regions to which extrapolation for management is required. Data-logging GPS collars greatly reduce or eliminate the need to conduct regular telemetry flights, allowing sample collection from study animals that are spread over a much greater range of conditions than otherwise may have been possible. The increased use of helicopter capture for bears also frees us from the need to work within well-defined study area bounds to which we would normally be limited by the logistics of trapping.

One final implication of the technologies relates to population trend monitoring. DNA/hair-snag techniques hold great potential for monitoring apparent population recruitment (as a result of reproduction and immigration) as well as survival and/or emigration (see Boulanger, this volume). For reasons discussed, conventional GPS collars are generally inappropriate tools for population monitoring. That is, we are unlikely to adequately track the histories or fates of individuals over long time frames. Determining mortality cause is also problematic given the typical low frequency with which download flights occur. However, collar models with satellite uplinks for frequent data transmission can potentially allow researchers to remotely monitor the activity of individual study animals on a daily basis, allowing site investigations to be conducted very soon after potential mortalities. This approach is currently being applied and tested in one recently initiated monitoring program (R. Mace, Montana Fish and Wildlife).

Conclusion

The technologies discussed have resulted in tremendous advancements in our ability to study and understand bear ecology and probable requirements at different ecological scales. However, also as a result, researchers have less time and less of a specific need to be in the field, with fewer opportunities to obtain an intimate sense of the complexities, nuances, and alternate hypotheses associated with the systems we study. This is particularly relevant for behaviourally complex species such as bears. The surrogate variables we derive from digital databases often do not adequately capture the factors that influence bear ecology and persistence, particularly at finer scales of space and time.

Select references

Apps, C., J. Boulanger, and M. Proctor. (2005). Grizzly bear population monitoring in the central Rocky and Columbia Mountains: a feasibility assessment with design options. Parks Canada, Mount Revelstoke, Glacier, Yoho, Kootenay, and Banff National Parks.

Apps, C. D., B. N. McLellan, and J. G. Woods. (2005). Landscape partitioning and spatial inferences of competition between black and grizzly bears. Ecography 29:561–572.

Apps, C. D., B. N. McLellan, J. G. Woods, and M. F. Proctor. (2004). Estimating grizzly bear distribution and abundance relative to habitat and human influence.Journal of Wildlife Management 68:138–152.

Boulanger, J., S. Himmer, and C. Swan. (2004). Monitoring of grizzly bear population trend and demography using DNA mark-recapture methods in the Owikeno Lake area of British Columbia. Canadian Journal of Zoology 82:1267–1277.

Boulanger, J., B. N. McLellan, J. G. Woods, and M. E. Proctor, and C. Strobeck. (2004). Sampling design and bias in DNA-based capture-mark-recapture population and density estimates of grizzly bears. Journal of Wildlife Management 68:457–469.

Boyce, M. S., and L. L. McDonald. (1999). Relating populations to habitats using resource selection functions. Trends in Evolution and Ecology 14:268–272.

Boyce, M. S., and J. S. Waller. (2003). Grizzly bears in the Bitterroot: predicting potential abundance and distribution. Wildlife Society Bulletin 31:670–683.

Corsi, F., J. de Leeuw, and A. Skidmore. (2000). Modeling species distribution with GIS. Pages 389–434 in L. Boitani and T. K. Fuller, editors. Research techniques in animal ecology. Columbia Unviersity Press, New York, New York, USA

de Leeuw, J., W. K. Ottichilo, A. G. Toxopeus, and H. H. T. Prins. (2002). Application of remote sensing and geographic information systems in wildlife mapping and modelling. Pages 121–144 in A. Skidmore, ed. Environmental modelling with GIS and remote sensing. Taylor and Francis, New York, New York, USA.

D'Eon, R. G., R. Serrouya, G. Smith, and C. O. Kochanny. (2002). GPS radiotelemetry error and bias in mountainous terrain. Wildlife Society Bulletin 30:430–439.

Foran, D. R., S. C. Minta, and K. S. Heinemeyer. (1997). DNA-based analysis of hair to identify species and individuals for population research and monitoring. Wildlife Society Bulletin 25:840–847.

Frair, J. L., S. E. Nielsen, E. H. Merrill, S. Lele, M. S. Boyce, R. H. M. Munroe, G. B. Stenhouse, and H. L. Beyer. (2003). Removing habitat-induced GPS-collar bias from inferences of habitat selection. Journal of Applied Ecology 41:201–212.

Gau, R. J., R. Mulders, L. M. Ciarniello, D. C. Heard, C. B. Chetkiewicz, M. Boyce, R. Munroe, G. Stenhouse, B. Chruszcz, M. L. Gibeau, B. Milakovic, and K. L. Parker. (2004). Uncontrolled field performance of Televilt GPS-simplex collars on grizzly bears in western Canada. Wildlife Society Bulletin 32:693–701.

May, R. M. (1994). The effect of spatial scale on ecological questions and answers. Pages 1–17 in Edwards, P. J., R. M. May, and N. R. Webb, editors. Large scale ecology and conservation biology. Blackwell Scientific Publications, London, England.

Mills, L. S. J. J. Citta, K. P. Lair, M. K. Schwartz, and D. A. Tallmon. (2000). Estimating animal abundance using non-invasive DNA sampling: promise and pitfalls. Ecological Applications 10:283–294.

Mowat, G., and C. Strobeck. (2000). Estimating population size of grizzly bears using hair capture, DNA profiling, and mark-recapture analysis. Journal of Wildlife Management 64:183–193.

Nielsen, S. E. (2004). Grizzly bear habitat ecology and population viability for the Yellowhead Region of Alberta, Canada. Ph.D. Thesis. University of Alberta, Edmonton, Alberta, Canada.

Paetkau, D. (2003). An empirical exploration of data quality in DNA-based population inventories. Molecular Ecology. 12:1375–1387.

Proctor, M., B. N. McLellan, and C. Strobeck. (2002). Population fragmentation of grizzly bears in southeastern British Columbia, Canada. Ursus 13:153–160.

Proctor, M., B. McLellan, D. Paetkau, C. Apps, G. Mowat, and J. Boulanger. (2007). Non-invasive DNA sampling yields a diverse suite of ecological investigations of grizzly bears in British Columbia, Canada, 1995 to 2005. Ursus. In Press.

Scott, J. M., P. J. Heglund, M. L. Morrison, J. B. Haufler, M. G. Raphael, W. A. Wall, and F. B. Samson. (2002). Predicting species occurrences: issues of scale and accuracy. Island Press, Covelo, Oregon, USA.

Skidmore, A., editor. (2002). Environmental modelling with GIS and remote sensing. Taylor and Francis, New York.

Stevens, S. (2001). Use of Landsat TM-based greenness as a surrogate for grizzly bear habitat quality in the Central Rockies Ecosystem. Eastern Slopes Grizzly Bear Project, University of Calgary, Calgary, Alberta, Canada.

Waits, L. P. and D. Paetkau. (2005). Non-invasive genetic sampling tools for wildlife biologists: a review of applications and recommendation for accurate data collection. Journal of Wildlife Management 69:1419–1433.

Wiens, J. A., B. Van Horne, and B. R. Noon. (2002). Integrating landscape structure and scale into natural resource management. Pages 23–67 in J. Liu and W. W. Taylor, editors. Integrating landscape ecology into natural resource management. Cambridge University Press, New York, New York, USA.

Woods, J. G., D. Paetkau, D. Lewis, B. N. McLellan, M. Proctor, and C. Strobeck. (1999). Genetic tagging of free-ranging black and brown bears. Wildlife Society Bulletin 27:616–627.

14. Recent advances in DNA mark-recapture methods to estimate population size and trend

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The main purpose of this talk is to provide an overview of a DNA-based method to estimate population size and trend for bear populations, and provide results from recent research projects. Since its invention at a Columbia Mountains Institute meeting in Revelstoke in 1996 (Woods *et al.* 1999), the DNA method has been used to estimate population size in 26 different projects in British Columbia and Alberta (Boulanger *et al.* 2002, Mowat *et al.* 2005). Through this process, study design has been refined with corresponding gains in estimate precision and optimization of project costs. Key elements in project success have been estimating closure violation, minimizing capture probability variation, and optimizing sample sizes. Sample size in the context of mark-recapture research is the number of bears captured and the recapture rate of the marked bears. I discuss three recent advances in mark-recapture methods.

Optimization of sampling design

One sample design question is whether it is necessary to move sites between sampling sessions and whether we were sampling all age groups of bears. We designed a recent project in Alberta to directly test the utility of these design methods. The main sampling method for this project used a traditional design in which bait sites were moved within 180 7 x 7 km grid cells for 4, 2-week sampling sessions in the spring of 2004. However, we also tested other strategies concurrently with the traditional design. We sampled fixed sites within each cell to test the utility of moving sites compared to the less expensive method of not moving sites. We also placed a second, lower strand of barbed wire on bait sites to see if this could identify cubs, which are not typically sampled by the usual knee-height strand of barbed wire. As detailed in Boulanger *et al.* (2006), moving sites with a single wire was determined most optimal of the designs considered.

Use of multiple data sources

The Northern Continental Divide Ecosystem DNA project pioneered the use of rub tree sampling to obtain DNA from grizzly bears (See *http://nrmsc.usgs.gov/research/beardna.htm*) (Kate Kendall, USGS, in prep.). We considered estimation methods to allow estimates of population size using DNA obtained from both traditional hair snag corrals and rub trees. In detail, we tested the Lincoln-Petersen estimator and a method using program MARK using both empirical data and simulation methods. Preliminary results suggest the MARK estimator is the most efficient. Simulation results also highlight potential limitations of this method. Publications on this work are upcoming.

Monitoring of trend

One of the fundamental needs of bear management is the monitoring of population trend. One newer method to estimate trend that has been proposed is the repeated DNA sampling of populations over time to obtain trend estimates using mark-recapture methods. I discussed results from a DNA mark-recapture trend monitoring project conducted on the coast of British Columbia (Boulanger *et al.* 2004). In addition, I used simulation methods to explore the robustness of the Pradel model (Pradel 1996) in program MARK (White and Burnham 1999) to likely sample biases present in bear populations such as heterogeneity of capture probabilities, closure violation, and reduction in capture probabilities of bears due to habituation to bait sites. Simulation results suggest that the Pradel model is relatively robust to sample most biases in grizzly bear populations.

In conclusion, the results of British Columbia studies show that reliable estimates of population size and trend are possible with DNA mark-recapture methods. Quantitative tools are available to produce estimates of population size, density, and trend however the ultimate quality and reliability of estimates is determined by sound attention to sampling design, field implementation, and genetic analysis.

References

(See *www.ecological.bc.ca/refs.htm* for more DNA mark-recapture papers)

Boulanger, J., S. Himmer, and C. Swan. (2004). Monitoring of grizzly bear population trend and demography using DNA mark-recapture methods in the Owikeno Lake area of British Columbia. Canadian Journal of Zoology 82:1267–1277.

Boulanger, J., M. Proctor, S. Himmer, G. Stenhouse, D. Paetkau, and J. Cranston. (2006). An empirical test of DNA mark-recapture sampling strategies for grizzly bears. Ursus In Press.

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.

Mowat, G., D. C. Heard, D. R. Seip, K. G. Poole, G. Stenhouse, and D. Paetkau. (2005). Grizzly Ursus Arctos and black bear U. americanus densities in the interior mountains of North America. Wildife Biology 11:31–48.

Pradel, R. (1996). Utilization of mark-recapture for the study of recruitment and population growth rate. Biometrics 52:703–709.

White, G. C., and K. P. Burnham. (1999). Program MARK: Survival estimation from populations of marked animals. Bird Study Supplement 46:120-138.

Woods, J. G., D. Paetkau, D. Lewis, B. N. McLellan, M. Proctor, and C. Strobeck. (1999). Genetic tagging free ranging black and brown bears. Wildlife Society Bulletin 27:616–627.

Presentations for the afternoon of October 25, 2006

Session chair, Dr. Bruce McLellan

15. Brown bear management in Alaska: Perspectives of four retired Alaska Fish and Game Department biologists

Presented by: Dr. Sterling Miller, National Wildlife Federation
millerS@nwf.org
John Schoen, Audubon Alaska, Anchorage, AK
Charles C. Schwartz, Interagency Grizzly Bear Study Team, Northern Rocky Mountain Science Center
Jim Faro, Sitka, AK

This presentation was also given at The Wildlife Society's annual conference (September 2006 in Anchorage, Alaska) as part of the special symposium "Conducting Wildlife Science in the Public Eye." A PDF of the PowerPoint of this presentation is available at: *http://www.mhfj.org/AKBearManagement.pdf*

Management of brown bears (*Ursus arctos*) and other large carnivores in Alaska has undergone marked changes over the last 25 years. In this paper, we focus on the changes in brown/grizzly bear management over this period from the perspective of biologists who formerly worked on bears as researchers and managers for the Alaska Department of Fish and Game. Trends in hunting regulations and bear management since the late 1970s raise concerns about the conservation and management of Alaskan grizzly bears over the long term. This concern results from the perceptions, by some politicians, managers, and hunter groups, that bears are undesirable predators and competitors for ungulate game species (primarily moose and caribou). These perceptions are increasingly being translated into regulations designed to reduce bear abundance over progressively larger portions of the state, especially on state-owned and Bureau of Land Management lands. In this paper, we document state-wide trends on the geographic range of liberalized hunting seasons, increased bag limits, elimination of tag fees for resident bear hunters, issuance of "control permits" allowing additional kills by permittees, legalized baiting of grizzly bears, legalization of the sale of bear parts, and the impacts of these changes on harvests.

Legal mandates from the Alaska legislature and from members of the Alaska Board of Game give Alaskan game managers little flexibility to reverse these trends. At the same time regulations are being liberalized, funds to assess trends in bear numbers are declining.

We recommend new approaches toward bear management in Alaska that we hope will avoid repeating some of the mistakes in bear management that occurred in the lower 48 states during the last century. With enlightened proactive conservation efforts and preventative management, Alaska can remain a stronghold for the grizzly in North America and a model for bear conservation throughout the world.

References

Miller, S.D. 1993. Brown Bears in Alaska: A statewide management overview. Wildlife Tech. Bull. 11, Alas. Dep. Fish and Game, Anchorage. 40 pp.

Miller, S.D., and J.S.Schoen. 1999. Status and management of the brown bear in Alaska. Pages 40-46 in C. Servheen, S. Herrero, and B. Peyton, eds. Bears: Status survey and conservation action plan. International Union for Conservation of Nature and Natural Resources/Species Survival Commission Bear and Polar Bear Specialists Groups, IUCN, Gland, Switzerland and Cambridge, UK.

16. A review of genetic methods for studying small populations

Dr. David Paetkau, Wildlife Genetics International, Nelson, BC
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No summary provided.

To find out more about Dr. Paetkau's work, please visit his Web site at:
www.wildlifegenetics.com

For a list of David's publications, visit:
www.wildlifegenetics.ca/our_publications.htm

17. Models use to extrapolate grizzly bear populations in British Columbia

Garth Mowat, BC Ministry of Environment, Nelson, BC
garth.mowat@gov.bc.ca

Extrapolating population size has been a controversial part of grizzly bear harvest management. Garth Mowat discussed a modelling effort that was used during the last harvest allocation period. He also discussed harvest management concerns raised in the Kootenays during a recent pilot project to revisit grizzly bear harvest policy in the Region.

The following list of publications under the heading, Grizzly Bear Population Estimates and Harvest Procedure, can be found at: *www.env.gov.bc.ca/wld/grzz/#gbpop_harvest*

- British Columbia's grizzly bear population estimates were revised in 2004 based in part on the recommendations from the independent Grizzly Bear Science Panel (see below). The new provincial population estimate is approximately 17,000 grizzly bears.
  British Columbia Grizzly Bear (*Ursus arctos*) Population Estimate 2004 (PDF15KB)

- Two major methods were used to derive these new grizzly bear population estimates. The first technique involves the use of a multiple regression model.
  Predicting Grizzly Bear (*Ursus arctos*) densities in British Columbia using a multiple regression model (PDF 195KB)
- The second technique used to derive these new grizzly bear population estimates is the expert-based approach.
  Estimating Grizzly Bear (*Ursus arctos*) Population Size in British Columbia Using an Expert-based Approach (PDF 855KB)
- The procedure for determining the allowable harvest levels for grizzly bears was also revised in 2004, in part on the recommendations from the independent Grizzly Bear Science Panel (see below).
  Grizzly Bear (*Ursus arctos*) Harvest Management in British Columbia (PDF 193KB)
- An analysis of reported human-caused grizzly bear mortalities in British Columbia from 1978–2003 has also been completed.
  An Analysis of Reported Grizzly Bear (*Ursus arctos*) Mortality Data for British Columbia from 1978-2003 (PDF 276KB)

18. Managing the grizzly bear harvest in British Columbia

Matt Austin, BC Ministry of Environment, Victoria, BC
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These notes are adapted from Matt's PowerPoint presentation.

Grizzly bear hunting in British Columbia has been a contentious issue for years.

- There have been campaigns by environmental non-government organizations (ENGOs) including the first citizens' initiative petition.
- A previous government implemented a short-lived moratorium.
- The European Union (EU) has blocked imports of harvested animals.

Why is it so controversial?

- Grizzly bears are an iconic species.
- "Trophy" hunting has low public support.
- Estimating the size of grizzly bear populations is inherently difficult.
- The decline of grizzly bear populations historically has been due primarily to excessive human-caused mortality.

The law

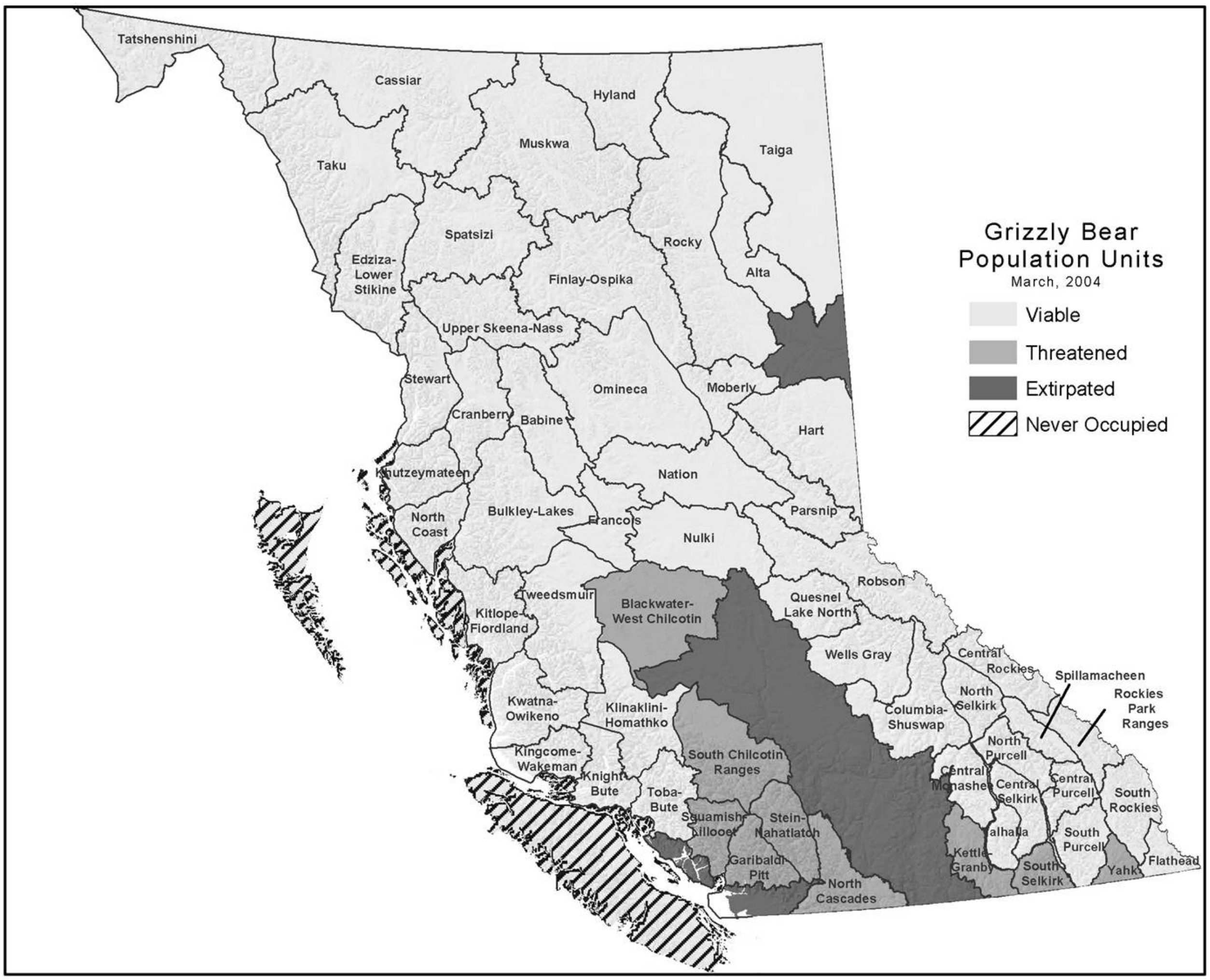
- All grizzly bear hunting in BC is regulated by Limited Entry Hunting and Guide Outfitter Quotas.
- It is illegal to kill a bear greater than 2 years old or any bear in its company.
- All animals killed are subject to compulsory inspection.
- Possession and trafficking in some bear parts is illegal.
- Baiting is illegal, dogs can be used.

- It is illegal to kill a bear in defence of hunted game.
- A CITES (the Convention on International Trade in Endangered Species of Wild Flora and Fauna) permit is required for export.

A question to ponder…

If someone could demonstrate beyond a doubt that grizzly bear hunting in BC was sustainable, how many people would change their position on whether or not to continue the practice? I suspect not many—if that is true, why have we spent so much time debating the science? This is a dilemma scientists often face.

Grizzly bears are managed on the basis of Grizzly Bear Population Units. A map of the population units follows.



Population estimation

- The multiple regression model is a more objective process than the habitat-based approach.
- We now use best estimates as opposed to minimum estimates.
- The multiple regression model is preferred over direct inventory results which, in turn, is preferred over the habitat-based approach.

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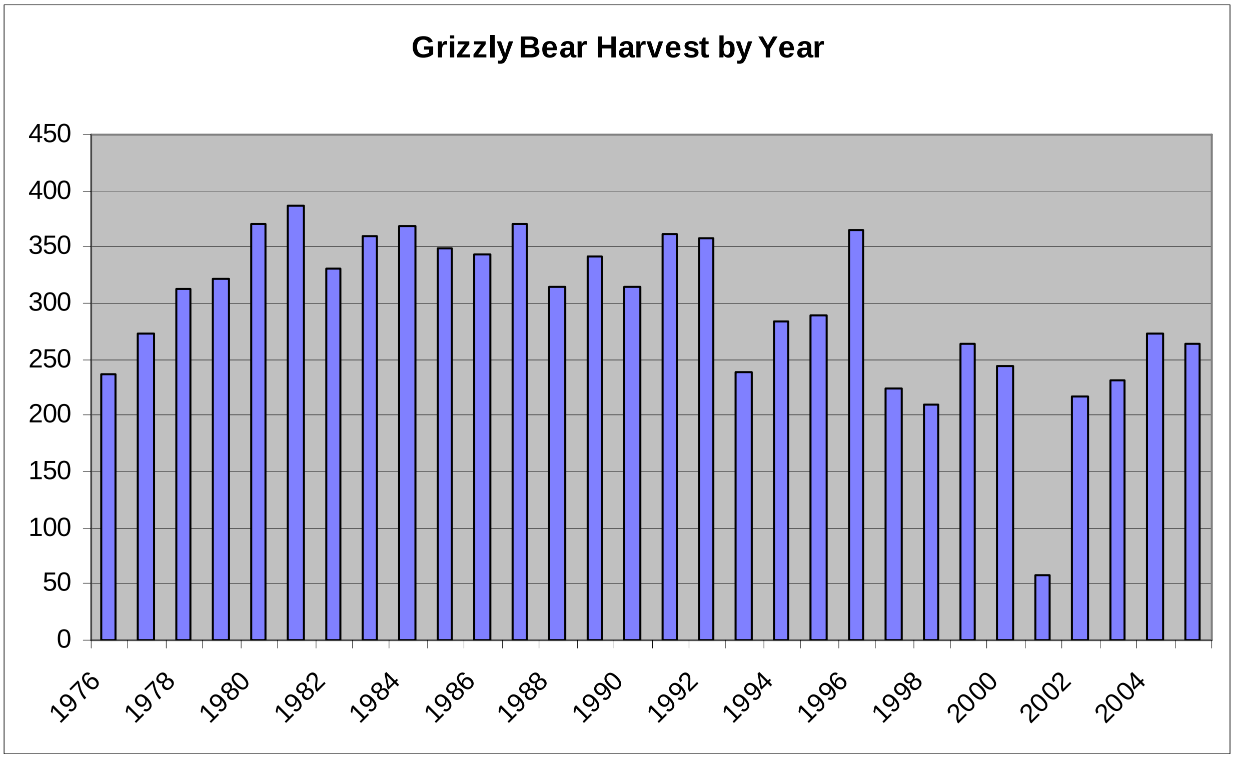
Grizzly Bear Population Unit (GBPU)	Habitat Capability in Areas with >5,000 People within 50 km	Hunter Day Density (days/1000 km²)	Large Ungulate Harvest Density (Animals/year/1000 km²)	% of Habitat Capability in > 0 km/km² Road Density Class	Unreported Mortality Rate (Unbounded)	Unreported Mortality Rate (Bounded between 0.3 and 3.0%)
ALTA	0.1	0.2	0.4	1.3	1.0%	1.0%
BABINE	0.5	0.2	0.7	0.4	0.9%	0.9%
BLACKWATER-WEST CHILCOTIN	0.0	0.2	0.8	0.7	0.9%	0.9%
BULKLEY-LAKES	0.8	0.1	0.5	0.4	0.9%	0.9%
CASSIAR	0.0	0.1	0.3	0.1	0.3%	0.3%
CENTRAL MONASHEE	1.2	0.7	0.1	1.2	1.6%	1.6%
CENTRAL PURCELL	1.2	0.5	0.5	0.6	1.4%	1.4%
CENTRAL ROCKIES	0.6	0.3	0.0	0.7	0.8%	0.8%
CENTRAL SELKIRK	1.1	0.3	0.1	0.9	1.2%	1.2%
COLUMBIA-SHUSWAP	0.8	0.4	0.2	1.1	1.2%	1.2%
CRANBERRY	0.4	0.1	0.2	0.4	0.6%	0.6%
EDZIZA-LOWER STIKINE	0.0	0.0	0.1	0.1	0.1%	0.3%
FINLAY-OSPIKA	0.0	0.0	0.1	0.2	0.2%	0.3%
FLATHEAD	1.0	1.0	1.0	1.0	2.0%	2.0%
FRANCOIS	1.0	0.3	1.1	1.0	1.7%	1.7%
GARIBALDI-PITT	1.2	0.2	0.0	0.9	1.2%	1.2%
HART	0.3	0.3	0.8	0.7	1.1%	1.1%
HYLAND	0.0	0.0	0.2	0.2	0.2%	0.3%
KETTLE-GRANBY	1.1	1.6	0.2	1.1	2.0%	2.0%
KHUTZEYMATEEN	0.9	0.0	0.1	0.4	0.7%	0.7%
KINGCOME-WAKEMAN	0.3	0.0	0.0	0.3	0.3%	0.3%

Risk management

- The biggest risk is the uncertainty in population estimates.
- Allowable mortality rates are adjusted based on this uncertainty and the level of acceptable risk.
- A sliding scale for maximum human-caused mortality is used based on current habitat conditions.



Future Directions?

- Spring seasons only?
- Once in a life time (or 5–10 years?) bag limit?
- Restrict sale of hides and claws?
- Economic disincentive for harvest of females?
- General open seasons in some areas?

19. Conference observations

Dr. Stephen Herrero, University of Calgary
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I observe that people involved in research and management regarding bears and the ecosystems they are part of are getting younger and younger. More importantly, these researchers are better informed regarding the increasingly complex quantitative and social means we use to understand bears in a world dominated by humans.

I also note that the Columbia Mountains Institute has again done a superb job of bringing us together to exchange information and ideas. Conference organization is not trivial. One needs the right mix of cutting-edge research and the ability to communicate. Also needed is the right format for sharing. Presenting papers and posters is the beginning; chatting over food during breaks is critical. Failure to orchestrate this can leave participants frustrated. This conference has brought us together and provided rich opportunities for learning. Special thanks go to Jackie Morris, Bruce McLellan, and John Woods.

No conference can cover every possible influence on bears in a rapidly changing North America. Please, forgive me for a somewhat fanciful addition. The influence of habitat and population fragmentation on bear populations was well covered. However, one major possible fragmenting influence received no mention. What if the United States Department of Homeland Security decides to erect a human-proof fence along the Canada/US border? Likely this would also be bear proof, and would create new and smaller population units across a vast area. As fanciful, even as silly as this sounds, such a fence has been proposed along the US border with Mexico and the implications for bears are huge.

By around 1980 there were no black bears in Texas; they had been extirpated. Mexico, which is not known for wildlife conservation, was a source of wild black bears that naturally dispersed back into Texas. This is exactly what biologists hope will happen in areas where habitat is not fragmented. More recently, panthers have come back into the United States, again into Texas, after being extirpated. Roughly half a dozen panthers may now be in Texas. Cut off from the parent population in Mexico, the Texas big black cats would probably not survive. The effects of the fear of terrorism on international border fencing are an example of how rapid changes in North America will require us to be alert for new, potentially major, influences on bears and ecosystems. Global warming and pine beetle population expansions are other examples.

A major theme of this conference was detailing how available food energy shapes bears as populations and individuals. Up to a point, a successful bear in a given area is bigger than competing individuals of the same species and sex. This is because mass is associated with breeding opportunities for males, and with the successful production and rearing of young for females. Ultimately, within an ecosystem, bears must adjust their size to the resources available to them. Research by Charlie Robbins and his students has shown that brown bears can only get so big feeding on green vegetation and berries. There are limits to herbivory. At some point, bears need meat (ungulates), fish (salmon), seals, or nuts to grow larger. The highest energy foods, the ones that support relatively dense populations of large bears, are ones that bears often compete for with humans. Even if they don't compete directly for high energy foods, they may lose out to alternate uses of the ecosystem, such as for recreation or intensive hunting (e.g., moose hunting in Alaska).

High energy resources come from productive ecosystems. Humans are changing these at a rapid rate. Recent, dramatic changes in some polar bear populations and habitat, due to global warming and related difficulty in hunting seals, were emphasized by Andy Derocher. Changes in huckleberry production are related to fire history in western forests. Most forest management does not have a role for natural fire. Salmon, the ultimate resource for growing big brown/grizzly bears and dense populations, are potentially threatened by the diseases associated with salmon farming in British Columbia as well as by the harvest in international waters. Whitebark pine nuts, an important high energy food for grizzly bears in Yellowstone and Glacier (Montana) National Parks, are declining. This is due largely to the invasion of an exotic fungus that causes blister rust. There is no room for complacency in anticipating and trying to manage the factors that might cause major declines in the production of high energy foods for North America's bears.

While threats to bear populations are diversifying, we should not forget the successes that have occurred along the way. Hunting of most, but not all, North American bear populations is at, or near, sustainable levels. A marked exception, underscored by Sterling Miller at the conference, is brown bear hunting in Alaska, where, in some places, an attempt is being made to depress brown bear populations to enhance moose production for hunters. In parallel with the general success of managed hunting there has been successful habitat protection in many areas. However, multiple uses, to the point of overuse, of brown/grizzly bear habitat have caused significant apparent population declines and range contraction in some areas such as Alberta.

Bear management, which is mostly the management of human activities to support bear conservation, is coming of age. It is a field that marries scientific research results with human dimensions. Chris Servheen underscored how successful bear management is built on four pillars: science, public support, political support, and support from institutions. The recovery of the grizzly bear population in the Yellowstone ecosystem is a telling example of what can be accomplished when these four elements work together. Critical in the recovery of this population has been the institutional framework. This has been provided by the classification of the grizzly bear in the contiguous United States as a threatened species in 1975. This resulted in political and public support for a myriad of actions that have underlain recovery. Such recovery might not be possible for other threatened or depressed populations where strong legislation does not exist to mandate recovery. There are only scattered examples of recent grizzly/brown bear population declines in BC. Such declines may be related to areas subject to logging, subdivision, or recreation. Tony Hamilton and others working for the BC government were not able to identify significant success in integrating grizzly bear needs into forest management plans.

At the same time that we struggle to integrate bears needs into human socio-political organization we continue to better understand bears and their needs. Our science marches forward. DNA research has revolutionized our understanding of bear populations and the influence of topography and human activities on population units and their distribution. Stable isotope analysis has revolutionized our understanding of the contribution of different foods to bears. GPS collars allow researchers ever more fine scale insights into habitat selection and movements by bears. Remote sensing and Geographic Information Systems (GIS) platforms offer powerful ways to analyze the relationship between landscape features and a bear's location, and to display this information in ways that many people understand. Our understanding of bears and their populations continues to advance with evermore powerful and essential mathematical, statistical, and modelling techniques. Presenting these has been one of the strengths of this conference.

Conservation of bears depends upon people valuing bears and translating these values into actions on the ground. The power and majesty of bears, the largest land carnivores left on earth, can inspire conservation action. Because of this, the results of research regarding bears have particular value. During the past 20 years bear viewing has become an industry generating millions of dollars in income and, at the same time, increasing concern for bears both as individuals and populations. I believe that bear viewing helps to create a passionate and informed constituency for conservation of bears and their habitat. Bear hunting can also do this. Conjoint support from viewers and hunters could evolve as a powerful coalition for bear conservation. However, inherent value differences between these groups must be resolved before effective coalitions are built.

Posters and Displays at Conference

The following is a list of posters and displays at the conference. Abstracts appear where they were provided.

1. **Marty Cancilla,** Rossland Bear Aware
   Haida Gwaii black bear hunt

2. **Neil Darlow,** Yellowstone to Yukon Conservation Initiative
   www.y2y.net/grizzly/default.asp
   Yellowstone to Yukon Conservation Initiative's grizzly bear strategy: Linking science to conservation action

3. **Jim Davis,** Conservation Partnership Centre
   www.bearinfo.org/home.htm
   Grizzly Bear Outreach Project

4. **Lori Homstol and Nicola Brabyn,** Bear Aversion Research Team, Whistler
   lhomstol@whistler.ca
   Aversive conditioning on black bears in Whistler

Summary of results from the 2005 field season
Of the 15 bears captured, we radio-collared 13 of them: five bears were adult females, five were sub-adult males, and three were adult males. We released bears at the capture site if possible, and gave them a "hard release" (with pain stimuli from beanbag rounds and rubber bullets) if they had a known conflict history. Several bears were captured and short-distance translocated a number of times, and given hard releases, but this did not seem to have any effect on their conflict level. Hard releases probably have the most potential to be effective when done on-site and in conjunction with attractant removal.

We translocated two bears long distances (over 30 km) and, in these cases, found this management tool to be ineffective. One bear died of unknown causes shortly after release (his carcass was not found until January), and the other was reported to be in conflict with humans at the translocation site.

Sub-adult male bears were the most persistent in accessing exclusion zones and exhibiting unwanted behaviours. All but nine of 85 non-release hazing and aversive conditioning events involved male bears. The nine exceptions were related to a single, 4–5-year-old female. Of those applications, 77% involved sub-adults. Despite consistent monitoring and application of non-lethal methods, bears were able to obtain a food reward in 46% of their attempts: 25% of cases involved garbage and 21% involved "natural" food (landscaped native or exotic flora). Bears seemed to be less likely to respond to human presence if they were eating either human or landscaped food.

We subjected a sub-adult bear to consistent aversive conditioning and the bear stopped entering the village for a short time (6 days). This led us to suspect that consistent aversive conditioning is probably more effective than hazing. However, the labour-intensity required is not sustainable for most jurisdictions, being nearly 24 hours for nine days. Bears subjected to hazing only did not change their behaviour; in many cases they continued to go to extreme lengths to get unnatural food.

The 2006 field season
We are piloting a more focused approach to aversive conditioning, using learning theory, for the 2006 field season. Applications to aversive conditioning include effective learning principles and effective punishment principles. Learning is most effective when it is evolutionarily relevant, and on a reinforcement schedule. Punishment, including the pain stimuli used in aversive conditioning, is most effective when it is:

- immediate,
- consistent,
- non-contingent,
- paired with a reward for alternative behaviour, and
- immediately intense.

We are investigating ways to capitalize on these principles to make aversive conditioning more effective.

5. **Minette Johnson,** Defenders of Wildlife
mjohnson@defenders.org
Models of collaboration between agencies and non-government organizations to reduce conflicts between grizzly bears and humans in the northern Rockies, USA

Too often relationships between state, federal, and tribal wildlife management agencies, and private conservation groups (non-governmental organizations [NGOs]) and private landowners are characterized by mistrust and suspicion by all. This is unfortunate because the objectives of these groups are broadly similar. In this paper, we present examples of co-operative projects that have used the combined strengths of NGOs and government agencies to provide tangible benefits to brown bears in the northern Rockies, USA.

Increasing populations of brown bears creates a greater likelihood of conflict between bears and humans, often resulting in bear mortality. Defenders of Wildlife has co-operated in the purchase of bear-resistant dumpsters and containers for campsites, recreation areas, and rural communities to prevent bear habituation to garbage. We have also acquired bear-resistant panniers for loan to guides and outfitters to enable them to keep a clean hunting camp; constructed "food hanging poles" at remote sites so hunters can hang their quarry or recreationalists can store their food beyond the reach of bears; built electric fences around calving grounds or sheep bedding grounds to protect livestock when they are most vulnerable; erected permanent electric fence around bee yards with a history of damage by bears; provided financial incentives to livestock growers to move their sheep or cattle from public land allotments with chronic predation problems to areas with fewer predators; and created educational materials—like brochures and television ads—to provide guidance to residents on simple steps they can take to reduce their chances of having problems with bears. These projects have reduced human-caused mortality of bears and have increased local acceptance of brown bears by private landowners. NGOs can enhance bear recovery by building partnerships with agencies, corporations, landowners, and other groups to prevent bear/human conflicts before they occur.

6. **Jenny Klafki,** Parks Canada
   jenny.klafki@pc.gc.ca
   www.pc.gc.ca/banff-bears
   Grizzly bears and people at Lake Louise

About 1.5 million people a year—up to 20,000 on a fine summer day—visit Lake Louise, an icon of Canada. The area also supports one of three concentrations of female grizzly bears in Banff National Park. This creates unique human-use and ecological challenges. Facilities were not designed to accommodate today's number of visitors. Encounters between people and wildlife have also increased, putting pressure on wildlife corridors, habitat, and sometimes public safety. Healthy functioning ecosystems depend on a diversity of healthy wildlife populations. If grizzly bears can persist in the central Canadian Rockies, many other species will also have the habitat they need to survive. Integrated solutions to improve conditions for people and wildlife have been identified with the participation of Lake Louise residents. A number of projects, collectively knows as the Lake Louise Area Strategy, are outlined in the park's management plan (2004). Park staff members are working to get these projects "on-the-ground" over a 5–7-year period. Continued discussion with residents and other stakeholders is important to help us fine-tune as we go.

7. **Jenny Klafki,** Parks Canada
   jenny.klafki@pc.gc.ca
   www.pc.gc.ca/transcanada
   Trans Canada twinning in Banff National Park: Moving people with nature in mind

Upgrading the Trans-Canada Highway in Banff from two lanes to a four lane, divided highway has occurred in stages over the last 25 years. To date, the 45 km section from the park's east gate to Castle Junction has been twinned and fenced, and 24 wildlife crossing structures built. Year-round monitoring of the crossings has occurred since 1996. The remaining 33 km section of highway between Castle Junction and the British Columbia-Alberta border, known as phase IIIB, has undergone an environmental assessment for twinning and is now being upgraded in segments as funding allows. Phase IIIB improvements include: widening to four lanes with a posted speed of 90 km/hr; improved alignments; 18 wildlife crossing structures; two pedestrian crossings; bridge upgrades; and other design features to improve conditions for people and wildlife. Highway fencing will also extend west of the upgraded highway segment. This moves the fence-end west of Lake Louise and ensures wildlife, particularly grizzly bears, are not funnelled into the hamlet. A wildlife overpass and underpass will be built in this fenced section. Parks Canada is exploring the possibility of including the hamlet of Lake Louise within the highway fence. This would not only keep grizzly bears off the highway, but also out of the townsite, which would benefit both people and bears.

8. **Cheryl Le Drew and Liam Wilson,** Lotek Wireless Inc.
   www.lotek.com
   Display on radio collars for wildlife

9. **Grant MacHutchon,** Safety in Bear Country Society
   machutch@mars.ark.com
   Safety in Bear Country Society Video Series

The Safety in Bear Country Society is a non-profit group dedicated to educating the public about safety around bears and reducing the unnecessary killing of bears. The society's primary educational tools are video programs that address human safety around grizzly, black, and polar bears, as well as ways people can reduce problems with bears where they live, work, or travel. Video programs completed to date are *Staying Safe in Bear Country, Working in Bear Country, Living in Bear Country,* and *Polar Bears: a Guide to Safety.* All profits from program sales go into future education efforts. Society members are bear biology and bear-human conflict specialists John Hechtel, Stephen Herrero, Grant MacHutchon, Andy McMullen, and Phil Timpany.

For more information and to order the videos, visit: *www.distributionaccess.com* Look in the "Educational Media Resources" box and select "Canada." Then in the search box, type "bear."

10. **Brian Milakovic,** UNBC and Environmental Dynamics Inc.
    b_milakovic@hotmail.com
    Stable isotopes, GPS, and remote sensing: Effective tools to examine temporal variation in diet and fine-scale habitat selection by grizzly bears in a multi-prey system

11. **Bernie Palmer,** Rocky Mountain Grizzly Centre, Fernie, BC
    bernie@rockiesnetwork.com
    http://grizzlycentre.com
    Rocky Mountain Visitor Centre: Our vision

The Rocky Mountain Grizzly Centre is a research, conservation, and education initiative focussing on the Northern Continental Divide Ecosystem of southeastern BC, northern Montana, and southwestern Alberta. Governments, individuals, corporations, foundations, and others who recognize and are committed to maintaining the unique natural heritage of the region, and the quality of life it offers to both man and bear, are coalescing around the Rocky Mountain Grizzly Centre project.

In 2002, the Rockies Institute Society was established to facilitate and administer a variety of projects to promote sustainability of human and natural ecosystems in the Rocky Mountains. The Society is also the originator of the Rocky Mountain Grizzly Centre concept and vision. From its infancy in the early 2000s to its growing following today, the Grizzly Centre concept emphasizes science as the basis for conservation, stewardship, and other activities that impact the habitat of the grizzly bear and natural processes of the region.

The Institute's goal is to develop a centre in affiliation with academic institutions that will be at the forefront of scientific research and its dissemination, whether conducted at the centre or elsewhere. Situated in a region that supports a significant grizzly population, the Fernie-based Rocky Mountain Grizzly Centre will collect, assimilate, and disseminate scientific data to be used in support of research, education, and interpretation that benefits the grizzly bear, humans, and the environment of the ecosystem. These activities will be housed in an environmental state-of-the art complex that will archive data, facilitate researchers, house educational and interpretive displays, provide a venue for discussion and debate, and provide a centre for community meeting.

12. **Abby Pond,** Revelstoke Bear Aware Society
    beaware@telus.net
    www.revelstokeberaware.org
    Revelstoke's Bear Aware Program

13. **Jennifer Reimer,** Parks Canada
    www.pc.gc.ca/banff-bears
    Bears and bear guardians in Banff National Park

14. **Joanne Siderius,** Kootenay Bear Aware
    siderius@netidea.com
    Bear hazard assessments and bear human management plans in Rossland, Castlegar, and Nelson

Bear conservation often depends upon managing and maintaining bear populations in proximity to human populations. Bears are often attracted to garbage, fruit, restaurant grease barrels, poorly maintained compost, pets and pet food, outside food freezers, bird feeders, and barbeques. Educating the public to keep bear attractants away from bears is important in reducing bear-human conflict, but it is equally as important to plan community strategies to reduce bear habitat within human communities. Bear-hazard assessments and bear–human conflict management plans are community attempts to reduce bear–human conflicts. Bear hazard assessments are often community maps and an accompanying report showing and discussing factors such as location of bear attractants, bear (and wildlife) travelways such as railway and power right-of-ways, bear sightings and mortalities, areas posing habitual conflict problems, and green areas bears use as staging areas. Bear–human conflict management plans are comprised mainly of recommendations based on the hazard assessment. This poster shows two bear hazard assessments and bear–human management plans: Rossland and Castlegar, two Kootenay communities. The Nelson hazard assessment is in a preliminary stage.

15. **Julie Tanguay,** Parks Canada
    www.pc.gc.ca/banff-bears
    The Roadside Guardian Project, Banff National Park

Conference Field Trips

Heavy rain and low clouds beset the field trips on October 26. We are impressed that both the field trip leaders and the participants persevered with the field trips! Such is life in the Interior Rain Forest in October.

Revelstoke's road to becoming a Bear Smart community

Abby Pond, Co-ordinator, Revelstoke Bear Aware Society
beaware@telus.net

Revelstoke has been a pioneer in developing bear awareness within the community. On this half-day field trip the Revelstoke Bear Aware Society's co-ordinator, Abby Pond, took the group to various sites around town to get a behind-the-scenes look at a Bear Smart program in action. For more information about the society, visit: *www.revelstokebearaware.org* .

Managing cutblocks and roads near avalanche chutes for bears

Del Williams, Revelstoke Community Forest Corporation
del@rcfc.bc.ca

On this field trip, forester Del Williams and bear researchers Bruce McLellan and Rob Serrouya took the group into bear habitat within avalanche chutes north of Revelstoke. The field trip focused on forestry-related issues of timber harvesting and road development within grizzly range. This trip also offered an opportunity to get some fresh air and spend a bit of time seeing Revelstoke's backcountry.