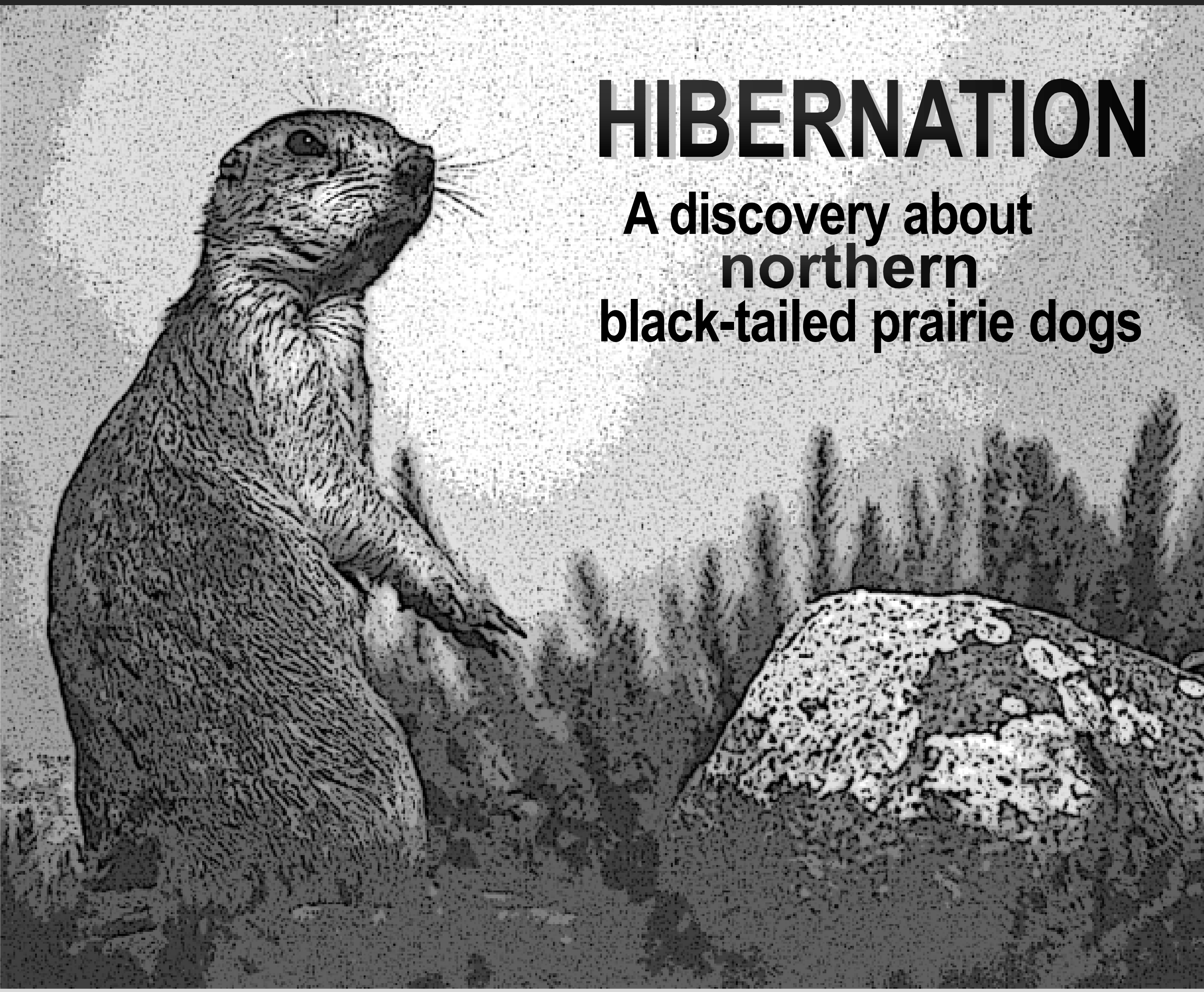
THE NATIONAL PARKS AND NATIONAL HISTORIC SITES OF CANADA
LES PARCS NATIONAUX ET LES LIEUX HISTORIQUES NATIONAUX DU CANADA
Canada

VOLUME 10 • NO. 2 • SUMMER/FALL 2002

Research Links

A FORUM FOR NATURAL, CULTURAL AND SOCIAL STUDIES

SPECIAL ISSUE: SPECIES-AT-RISK



BAT ROOST SELECTION • CARIBOU HABITAT ANALYSIS • BADGER POPULATION ECOLOGY

Parks Canada Parcs Canada
Canada

Research Links

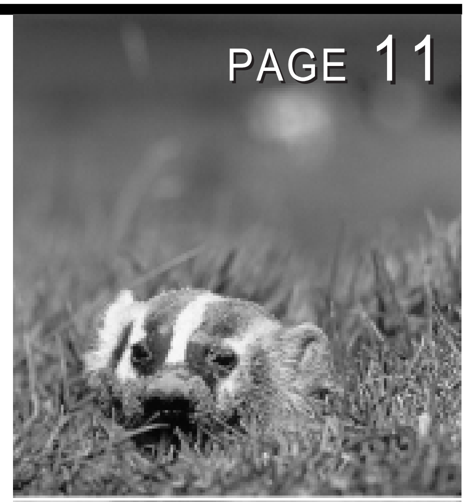
SUMMER/FALL 2002
SPECIAL ISSUE: SPECIES-AT-RISK

CONTENTS

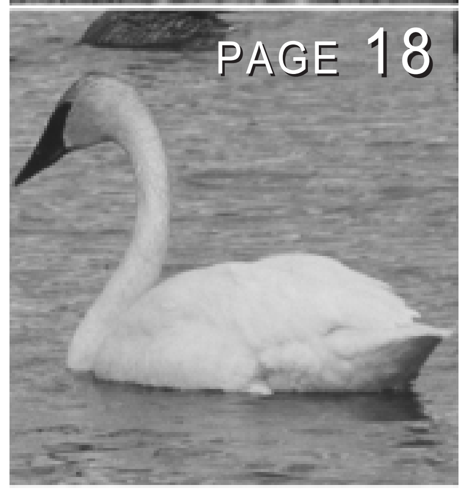
FEATURE ARTICLES

RESEARCH HIGHLIGHTS

DEPARTMENTS

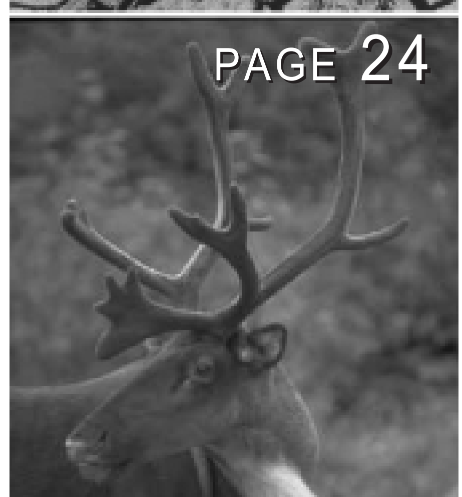


T. MCALLISTER



B. ANDERSON

A. PROMAINE



T.J. SCHWANKY

Editorial

As the current environment changes, conservation biologists are experiencing new challenges for the recovery of species at risk. The relative distribution of species abundance is changing, with increasing numbers of both abundant, widely-distributed species and rare, narrowly-distributed ones. The latter are often today's at risk and locally extirpated species. If nothing is done, rare, narrowly-distributed species will likely be the extinct species of tomorrow.

The new Canada National Parks Act identifies the maintenance and restoration of ecological integrity in national parks as our primary goal. Maintenance and recovery of rare species, particularly those at risk of extinction, is an integral part of this mandate. This mandate is legislated in the proposed Species at Risk Act (SARA), which will introduce new obligations for recovery planning and the protection of listed species and their habitat. These responsibilities call for a better scientific understanding of the ecology of species at risk and the methods needed to recover them.

This issue of Research Links highlights Species at Risk, presenting research results and management implications. However, as we showcase successes, we are also conscious of new challenges ahead. From a research point-of-view, these include the recovery of little-known non-charismatic species, and multi-species recovery planning.

In the past, most of Parks Canada work on species at risk has focused on a few charismatic species, such as the bison, the grizzly, and the piping plover. However, our definition of ecological integrity, and the terms of SARA, require us to protect and recover all of the approximately 200 species at risk present in national parks. For many of these species, the basic ecological information necessary to define appropriate conservation measures is not available. We also need to define indicators and protocols that will provide early warning of a deteriorating species' status, or feedback on the positive impact of recovery actions. Modelling of population viability is a powerful but underused tool in this context.

An important challenge for Parks Canada will be planning and prioritising actions for the recovery of multiple species occurring at a single site. In some cases, the same action will benefit an entire community, as in Garry Oak ecosystems (page 29). But, in other cases, the actions necessary for one species may be detrimental to others. The Parks Canada Species at Risk Program will be organising a special symposium during the 2003 SAMPAA meeting to promote discussion of this issue that conservation biologists have, so far, largely failed to address.

Parks Canada's revised mandate and legal obligations require that our knowledge of species at risk increases. Over the last two years, the newly established Parks Canada Species at Risk Program has provided financial support for approximately 100 research and management projects. Unfortunately, the demand is high and funds are limited … but we are committed to continue supporting valuable projects.

Gilles Seutin, National Coordinator, Species at Risk Program, Parks Canada. Tel: 819-994-3953; gilles_seutin@pch.gc.ca

CORRECTION

In "Amphibian Monitoring in Elk Island National Park" (Research Highlights, *RL* 10[1]) the photo caption incorrectly identified a Western Toad; the photo is actually of a Wood Frog. Thanks to Ross Chapman for bringing this to our attention.

UPCOMING DEADLINES

Research Links is a multidisciplinary publication that highlights research from the natural, cultural, and social sciences, and reports this research to a wide audience. Deadlines for submissions to future issues are: 2002 Nov 29 (Spring 2003); 2003 Mar 28 (Summer/Fall 2003).

FRANCOPHONES

Le texte de cette publication est offert en français. Vous pouvez l'obtenir en écrivant à l'adresse à la page 32.

RESEARCH LINKS ONLINE

Previous issues of *Research Links* are available online at http://parkscanada.pch.gc.ca under "Library", in the "Download Documents" section.

Seasonal Activities of Northern Black-tailed Prairie Dogs in Grasslands National Park

*David Gummer, François Messier, and Malcolm Ramsay**


D. GUMMER

Northern Black-tailed Prairie Dog

Black-tailed prairie dogs (*Cynomys ludovicianus*; henceforth prairie dogs) are relatively large (approximately 1 kg), highly social squirrels that live in large colonies on flat river valleys and upland grasslands in the Great Plains of west-central North America. Only a small fraction of the overall species' geographic range occurs in Canada, near the Frenchman River in and adjacent to the West Block of Grasslands National Park in extreme southwestern Saskatchewan. The nearest known prairie dog colony to the south, in Montana, is approximately 20 km away and there are only two Montana colonies known to occur within 50 km of the Canadian population. Given that prairie dogs occur in a very small area of Canada, at the very northern periphery of the species' range, and are geographically isolated beyond the typical dispersal distance of southern conspecifics, the Canadian population of prairie dogs is particularly sensitive to human activities and natural events. Hence, prairie dogs have been considered "Special Concern" since 1978 by the Committee On the Status of Endangered Wildlife In Canada (then "vulnerable"; Gummer 1999, Laing 1988, COSEWIC 1978).

Despite their long-time designation as a conservation priority, there is little known about the biology and ecology of prairie dogs at the northern periphery of the species' range. We studied the ecology of the northernmost prairie dogs from 1997 to 2001 to address this knowledge gap by investigating whether northernmost, peripheral occurrence influences the seasonal behaviour and physiology of prairie dogs, compared to literature accounts of more southern populations.

As a northernmost population, the prairie dogs of Grasslands National Park presumably experience greater annual variation in climate than more southern, core populations of the species. Black-tailed prairie dogs are not known to hibernate in nature (Harlow 1997, Harlow 1995, Hoogland 1995), nor are they known to store large amounts of food in their underground burrows (Jillson 1871, Sheets et al. 1971). Aboveground foraging activities of northern prairie dogs are probably constrained by continuous snow and cold temperatures. Therefore we hypothesized that the northernmost prairie dogs hibernate to conserve metabolic resources during winter. It is important to have an accurate understanding of the characteristics of the population to avoid potentially erroneous habitat and population models, conservation planning, or management decisions, especially if there is good reason to expect the population to have characteristics that differ from those available in the literature for other populations of the species.

STUDY AREA AND METHODS

We conducted fieldwork at three different prairie dog colonies in the West Block of Grasslands National Park (Fig. 1). During autumn (September to November) and spring (March to May), we trapped prairie dogs at semi-permanent trap sites using mesh live traps (Tomahawk Co.) baited with a small amount (5 g) of peanut butter and rolled oats. We uniquely identified each individual prairie dog by implanting a passive integrated transponder (Avid Canada) subcutaneously on the animal's lower back using a sterile syringe and 12-gauge needle. We also recorded the mass, sex, age class, and reproductive status of each prairie dog, for documentation and analysis of seasonal activity patterns and body mass variation.

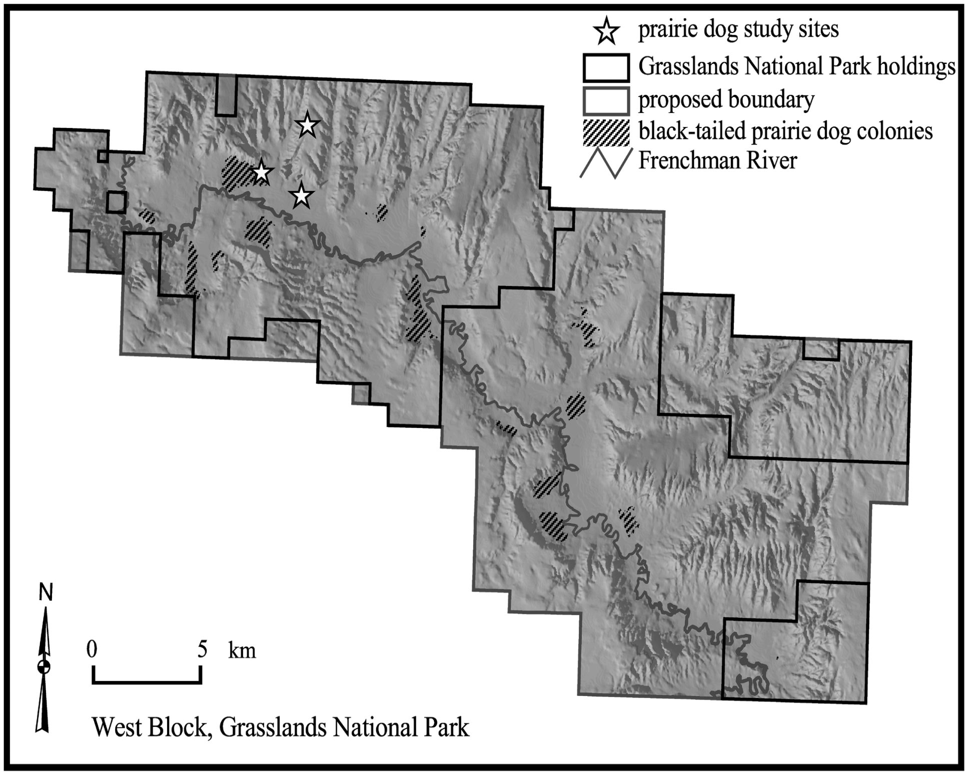


Figure 1. We studied the seasonal activities of northern black-tailed prairie dogs at three study sites located in three different prairie dog colonies in the West Block of Grasslands National Park. The digital elevation model, current park holdings, proposed boundary, and prairie dog colonies within the proposed boundary are shown for reference.

During autumn, we implanted miniature temperature sensitive dataloggers (Onset Computer Corp.) in the abdominal cavities of 25 prairie dogs to record the seasonal thermoregulation profiles of individuals. The dataloggers recorded core body temperature every 30 minutes for up to 677 days (32,520 measurements). They were coated in wax (Mini-mitter Co.) for waterproofing and to maintain the implant in a free-floating, retrievable state in the animals' abdominal cavities (Van Vuren 1989). The dataloggers weighed 15 g and measured 30 x 41 x 17 mm. We conducted surgeries in the field using standard, semi-sterile techniques. We anaesthetized prairie dogs for surgeries by intramuscular injection of telazol or by administering isoflurane (2 to 4%) gas with oxygen from a customized precision vaporizer. There were no accidental mortalities of prairie dogs during surgery or recovery. Each implanted prairie dog was released directly into the burrow at its capture location. During the following spring, we conducted intensive live trapping at each prairie dog's capture location to recapture implanted individuals and surgically recover the dataloggers.

RESULTS AND DISCUSSION

We captured 191 individual prairie dogs from 1997 to 2001, from a total of 1118 captures during 2933 trap days at three prairie dog colonies in the West Block of Grasslands National Park. We are using these capture records for in-depth analyses of seasonal activities of the various sex and age groups of prairie dogs, juvenile growth, survival rates, and adult body mass variation. However, to date the most noteworthy findings have been the results from the implanted temperature dataloggers: verification that the northernmost prairie dogs do indeed undergo hibernation during winter.

We recaptured 12 of the implanted prairie dogs after winter. The implanted prairie dogs did not appear to suffer measurably poorer overwinter survival compared to prairie dogs that had not undergone surgical implantation of dataloggers ($Chi^2 = 1.17$, df = 1, $p = 0.28$). Overall, we accumulated 138,024 temperature measurements from the 12 implanted prairie dogs for analyses of seasonal thermoregulation. The thermoregulation profiles that we recovered from the dataloggers showed that every implanted prairie dog used shallow hibernation (torpor) during autumn and spring and they adopted deeper, more long-term hibernation cycles during winter, as evidenced by the drastic changes in core body temperature (Fig. 2).

Overall, we documented 233 hibernation cycles during which core body temperature dropped below 30°C. Of those, 113 hibernation cycles had a duration of less than one day (i.e., torpor; 5.75 +/- 0.5 h, range 0.25 to 24 h) whereas 120 were multi-day episodes (i.e., hibernation; 6.5 +/- 0.25 d, range 1.25 to 13.5 d). During hibernation, core body temperatures of implanted prairie dogs reached minima ranging from 7.1 to

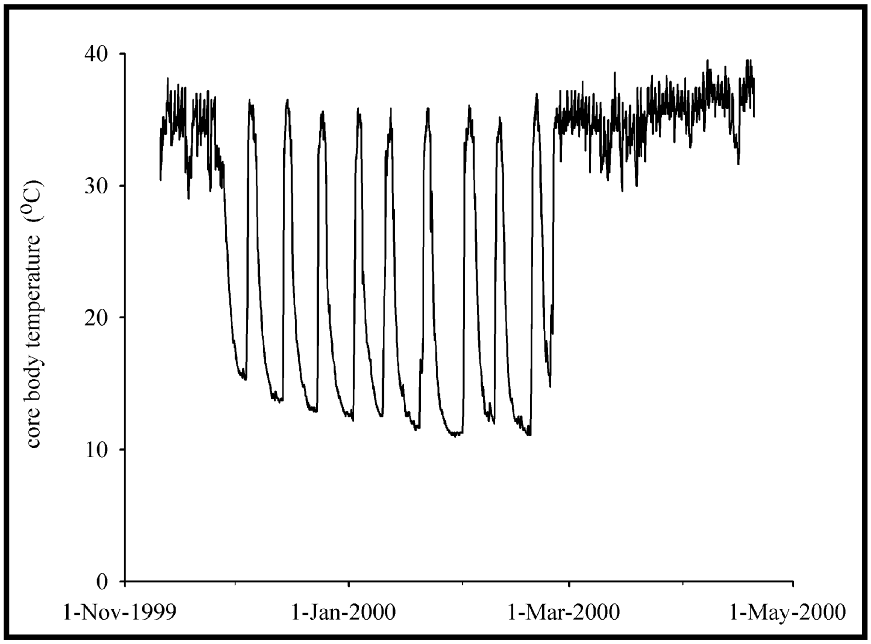


Figure 2. The northernmost black-tailed prairie dogs hibernate during winter, as evidenced by the drastic changes in core body temperature of this adult male prairie dog.

respond by minimizing hibernation time due to the threat of predation. Regardless of the possibility of future ferret reintroductions, it is clear that the Canadian population of prairie dogs is unique within the species in its extensive use of hibernation to survive each long, cold winter.

David Gummer, Curator of Mammology, Provincial Museum of Alberta, Edmonton, AB. Tel: (780) 453-9125; david.gummer@gov.ab.ca

François Messier, Biology Dept., University of Saskatchewan, Saskatoon, SK. Tel: (306) 966-4421; francois.messier@usask.ca

**Malcolm Ramsay was killed in a tragic helicopter accident in the Canadian Arctic on May 21, 2000.*

11.6°C. On 119 occasions, core body temperatures dropped below 15°C, which is an arbitrary threshold temperature that is commonly used to define deep hibernation.

Clearly, the Canadian population uses hibernation to conserve metabolic resources during winter, although previous literature accounts of more southern populations indicated that the species does not hibernate (Harlow 1997, Harlow 1995, Hoogland 1995). During the course of our research activities, however, other researchers discovered that 5 prairie dogs in Colorado used torpor twice during inclement winter weather (Lehmer et al. 2001). It appears that prairie dogs throughout their geographic range may have some capacity for reducing their metabolism during periods of inclement weather; however, we expect that only in the very northernmost periphery of the species' range do prairie dogs rely on regular and intensive hibernation cycles to survive long periods of harsh winter conditions.

While our findings have many direct implications for conservation and management planning for prairie dogs, they also have secondary implications for conservation of many other species at risk that rely on prairie dogs for creation of habitat (colonies) or as a prey base. Most notable is the possibility of an interaction between prairie dog hibernation and predation by black-footed ferrets (*Mustela nigripes*), which are specialist predators of prairie dogs but were extirpated. Ferret reintroductions are being conducted at prairie dog colonies in the United States and may be considered in future for Canadian prairie dog colonies. Hibernating prairie dogs in their underground nests would be highly susceptible to predation by ferrets. If ferrets were reintroduced there would be an abundant winter prey base of hibernating prairie dogs, but eventually the prairie dog population may

REFERENCES CITED

COSEWIC. 1978. *Status of the black-tailed prairie dog Cynomys ludovicianus in Canada*. Committee On the Status of Endangered Wildlife In Canada. Ottawa, ON.

Gummer, D.L. 1999. *Updated status of the black-tailed prairie dog Cynomys ludovicianus in Canada*. Committee On the Status of Endangered Wildlife In Canada. Ottawa, ON.

Harlow, H.J. 1997. Winter body fat, food consumption and nonshivering thermogenesis of representative spontaneous and facultative hibernators: the white-tailed prairie dog and black-tailed prairie dog. *Journal of Thermal Biology* 22: 21-30.

Harlow, H.J. 1995. Fasting biochemistry of representative spontaneous and facultative hibernators: the white-tailed prairie dog and the black-tailed prairie dog. *Physiological Zoology* 68: 915-934.

Hoogland, J.L. 1995. *Black-tailed prairie dog: social life of a burrowing mammal.* University of Chicago Press. Chicago, IL.

Jillson, B.C. 1871. Habits of the prairie dog. *American Naturalist* 5: 24-29.

Laing, R. 1988. *Updated status report on the black-tailed prairie dog* (*Cynomys ludovicianus*) *in Canada*. Committee On the Status of Endangered Wildlife In Canada. Ottawa, ON.

Lehmer, E.M., B. Van Horne, B. Kulbartz, and G.L. Florant. 2001. Facultative torpor in free-ranging black-tailed prairie dogs (*Cynomys ludovicinaus*). *Journal of Mammalogy* 82: 551-557.

Sheets, R.G., R.L. Linder, and R. Dahlgren. 1971. Burrow systems of prairie dogs in South Dakota. *Journal of Mammalogy* 52: 251-254.

Van Vuren, D. 1989. Effects of intraperitoneal transmitter implants on yellow-bellied marmots. *Journal of Wildlife Management* 53: 320-323

Rare Plants DISCOVERED in Elk Island National Park

Recently, a combination of research and volunteer surveys in Elk Island National Park (EINP) has discovered a number of rare ferns called moonworts. Several of the researchers and myself visited the moonwort sites on June 2/2002 and reconfirmed these plants are still thriving in small numbers. Without this combined effort, these discoveries would remain unnoticed.* These plants belong to the genus *Botrychium* and are the largest group of rare ferns in Alberta. Of special concern in EINP is *Botrychium pallidum*, which is endemic to North America and globally rare, known from Michigan, Ontario, Manitoba, Saskatchewan and Colorado. *Botrychium pallidum* is of special concern in EINP because it is the only known Alberta population and the western-most population in Canada. Alberta Environment has placed this species on its provincial tracking list (Gould 2001).

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has not yet assessed the status of any of the abovementioned *Botrychium* species; in fact, these species are just a minor portion of some 400 plant taxa that are considered rare in Alberta (Gould 2001), few of which have been assessed (Lorna Allen, pers. comm).

Williston (2002) has studied the basic ecology of these moonworts. Interestingly, moonworts in Elk Island NP have been found in disturbed sites. Although there has been some concern about high ungulate numbers in the park, bison, elk, deer, and moose are partly responsible for creating favorable habitat for these ferns. Moonworts are most prevalent along the edges of old access roads, park user trails, and game trails that are persistently grazed and browsed by the park's ungulates. Bison wallows are also favorite locations for these ferns. However, basic ecology of these ferns remains unclear:

PATRICK WILLISTON

Botrychium michiganense

"...many Botrychium species are able to colonize sites with anthropogenic disturbances, and…the availability of suitable habitat may not be limiting the distribution of most moonworts… Furthermore, because their spores are very small and easily transported by wind, dispersion should not be limiting either. The question remains, why are these ferns so rare? The answer is not known, but may relate to the dependence of these ferns upon endophytic fungi for gametophytic survival...Until we understand the limitations of their distribution, it is necessary to protect populations of rare moonworts where we know them to exist" (Williston 2002).

Based on current information, Elk Island will exercise precaution, with park management actions to protect these rare plants including zero summer vehicular access to old cut lines and management roads (e.g., the old Cooking Lake Road) to prevent excessive disturbance. This management will continue until the role of disturbance (including its kind, intensity and timing) in the ecology of these species is better understood, and annual surveys assess population trends and determine additional management needs.

Ross Chapman, Conservation biologist, Elk Island National Park, ross.chapman@pch.gc.ca

*the author wishes to thank the volunteers and researchers who discovered rare plants in Elk Island, including Dr. P. Achuff, L. Allen, P. Cotterill, J. Gould, G. and D. Griffiths, and K. Vujnovic. Patrick Williston added to the species list in his recently completed survey of genus *Botrychium* in Alberta.

References

Gould, J. 2001. *Alberta Natural Heritage Information Centre Tracking and Watch Lists – Vascular Plants, Mosses, Liverworts and Hornworts*. Alberta Environment. Edmonton, Alberta.

Lorna J. Allen, Biologist, Parks and Protected Areas Division, Alberta Community Development, Edmonton, AB. Tel: (780) 427-6621; lorna.allen@gov.ab.ca.

Williston, P. 2002. *The Botrychiaceae of Alberta: A Survey of Element Occurrences of the Genera Botrychium and Sceptridium in Alberta*. Report prepared for Resource Data Division, Alberta Sustainable Development. 18 p.+ app.

Alberta plants of conservation concern are summarized in the *Alberta Natural Heritage Information Centre Tracking and Watch Lists: Vascular Plants, Mosses, Liverworts and Hornworts.* Copies can be obtained at ANHIC's website http://www.cd.gov.ab.ca/preserving/parks/anhic/index.asp, or by writing to: Alberta Natural Heritage Information Centre, Parks and Protected Areas, 2nd Fl., Oxbridge Place, 9820-106 St., Edmonton, AB T5K 2J6 (Tel: 780-427-5209)

Roost selection by long-eared bats (*Myotis septentrionalis* and *M. evotis*) in the interior wet-belt of British Columbia

M.C. Caceres and R.M.R. Barclay

Recent studies have examined roost selection in forest-dwelling bats, primarily reproductive females (for example, Foster & Kurta 1999, Sasse & Pekins 1996, Vonhof & Barclay 1996). In temperate forests, reproductive females prefer roosts located in large trees, generally above the forest canopy or in a canopy gap, with uncluttered entrances. Standing dead trees with cavities, cracks or peeling bark are commonly selected by bats for roost trees, and individuals frequently switch between roosts. These tree types are more often found in older forest stands, suggesting that forest age is also important for bats. For reproductive females, warm roosts that allow female bats to maintain a constant body temperature at little cost, and larger roosts that allow for maternity colonies to form, should be important (Kunz 1982). In contrast, male and non-reproductive female forest-dwelling bats roost alone or in small groups away from maternity colonies, and may be more flexible in their roost selection.

We tested whether roost-use differs between commonly studied, reproductive bats, and male or non-reproductive bats. We investigated roost selection of the northern long-eared bat, *M. septentrionalis*, and the western long-eared bat, *M. evotis*, in the interior wet-belt of BC (including Glacier and Mount Revelstoke National Parks, Figure 1, see Caceres 1998). The bat population we studied is primarily non-reproductive. Thus, we expected roost-use to be more variable than found in previous studies of roost selection by reproductive females.

We also tested whether *M. evotis* is flexible in its roost selection in the interior wet-belt and whether *M. septentrionalis* behaves similarly. The range of *M. septentrionalis* in BC appears to be limited to the eastern mountain ranges and northeastern boreal forest, although it is rarely captured within its range (Nagorsen & Brigham 1993) and is blue-listed (vulnerable) by the BC provincial government. *M. evotis*, an ecologically similar species, is more common and is found throughout southern and central BC and extends into the southern

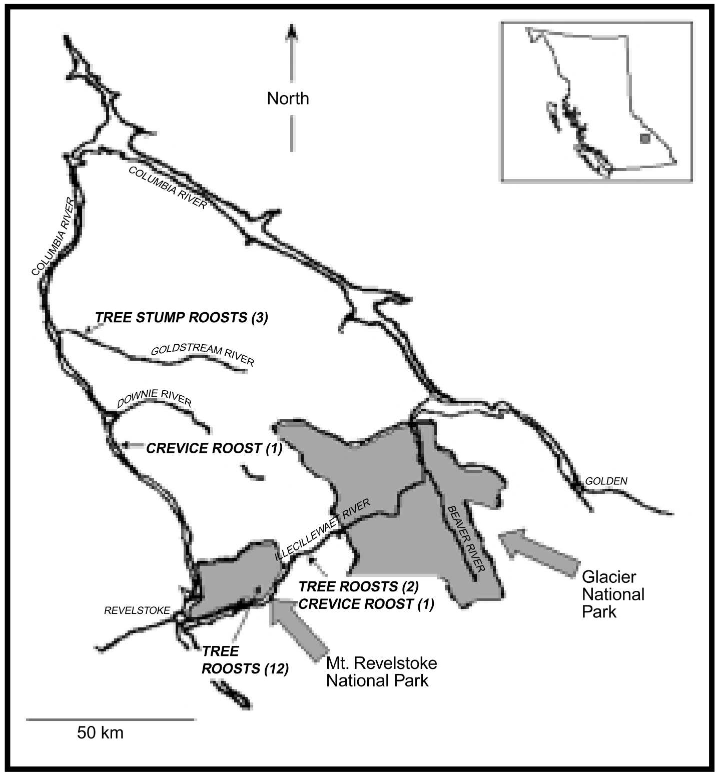


Figure 1. Schematic map of the study area; includes the national parks and some landmarks. Inset gives the location of the study area within British Columbia. Also shown is the approximate location of all roosts found.

Prairie provinces (Nagorsen & Brigham 1993). The interior wet-belt region of BC is the only known area of overlap for these species, and both species have been consistently captured in Mount Revelstoke National Park, making this an important area, particularly for the rare *M. septentionalis*. In other areas *M. evotis* is known to use cracks in the ground, rock crevices, wildlife trees (dead or dying trees), and even tree stumps left in clear-cuts (Vonhof & Barclay 1997). Given the importance of roosts to bats, understanding the roost selection of a rare species can greatly assist in park management and planning for the species.

METHODS

We located roosts using radio telemetry. For each tree roost, we measured the tree's diameter at breast height (DBH), height, and percent canopy closure. We also estimated percent bark remaining (visually), identified the tree to species, and classified it by decay stage (Vonhof & Barclay 1996). We measured canopy height and DBH of all trees (>15 cm) within a 17 m-radius plot around the roost tree and classified all trees in the plot by decay stage. Past studies have shown bats generally select roosts in trees between decay stage 2-7 (Vonhof & Barclay 1996). Of the trees in this decay range, we randomly selected 2 trees within the plot and measured the same characteristics as for the roost tree. We then established 2 other 17 m-radius plots around randomly selected wildlife trees (decay stages 2-7) at 100-300 m from the roost tree (see Caceres 1998). The same protocol was used at the 2 random plots as at the roost tree plot.

RESULTS

We located 14 roost trees (5 *M. evotis*, 9 *M. septentrionalis)* by following 11 radio-tagged individuals. All *M. evotis* and 7 *M. septentrionalis* tree roosts were in the vicinity of the Giant Cedars and Skunk Cabbage boardwalk trails, Mount Revelstoke National Park, with the remaining 2 *M. septentrionalis* roosts in a small group of trees at Jumping Creek (between the national parks, Figure 1). In addition, we found 3 roosts in tree stumps and 2 in rock crevices (4 female, 1 male *M. evotis*, Figure 1).

We initially analyzed the characteristics of roost trees used by *M. evotis* (5 roosts) and *M. septentrionalis* (9 roosts) together in order to determine whether the general characteristics of the roost trees selected were similar to those found in other forest-dwelling bat studies. Roost trees were taller and wider than randomly available nearby trees (within 17 m of the roost, 2-factor MANOVA, Wilks' lambda = 0.61, $F_{8,70}$ = 2.45, p<0.05, Figure 2). Stand characteristics (canopy height, number of trees, average DBH, total basal area occupied by trees of DBH > 15 cm) of plots centered on a roost tree and those centered on randomly chosen trees were not significantly different. However, roost trees differed from randomly-selected trees 100-300 m from the roost in that roost trees were taller and had less canopy cover (2-factor MANOVA, Wilks' lambda = 0.75, $F_{4,33}$ = 2.81, p<0.05, Figure 2).

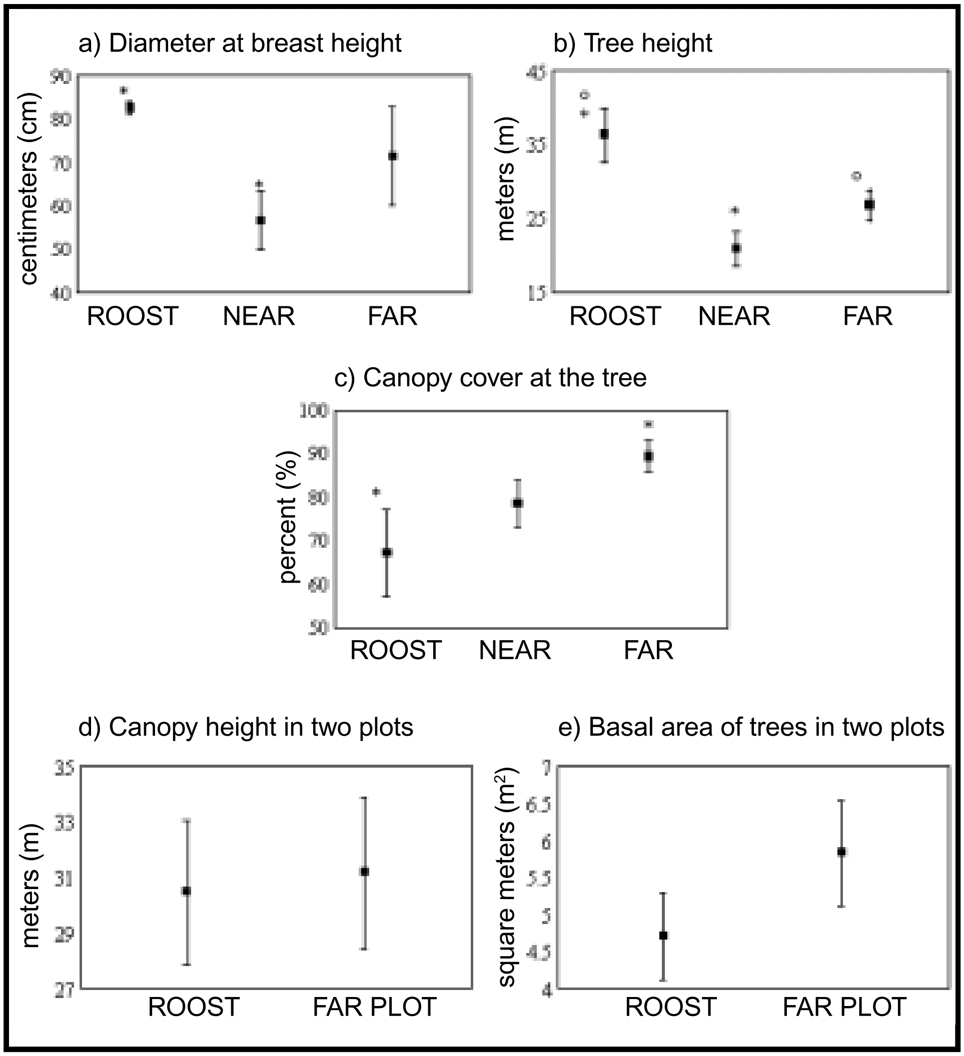


Figure 2a-e. Characteristics (± SE) of roost trees (n = 14), random trees within 17 m of the roost (n = 26, Near) and random trees (or plots) located 100 – 300 m from the roost tree (n = 23, Far). Means denoted by the same symbol (* or °) are significantly different (2-factor MANOVA).

The limited data suggested that there might be differences in the roosts preferred by *M. septentrionalis* and *M. evotis*. The roosts used by *M. septentrionalis* had significantly more canopy cover around them (Mann Whitney U-test, $U_{9,5}$ = 39, p<0.05, Figure 3) and a significantly higher canopy in the roost plot (Mann Whitney U-test, $U_{9,5}$ = 38, p=0.05, Figure 3). Other roost or plot characteristics were not significantly different between species. The trees used by *M. septentrionalis* were usually (6 out of 9 trees) within a forest canopy, whereas *M. evotis* roost trees were generally along forest-opening edges such as beside a river or highway (4 of 5 trees). These differences were not significant. *M. septentrionalis* was only found roosting in trees, whereas *M. evotis* used trees, rock crevices, and tree stumps.

DISCUSSION

Male and non-reproductive female long-eared bats in interior wet-belt forests appear to select for the same basic roost criteria as reproductive females in other forests. The long-eared bats of our study area rely on taller trees with less canopy closure than is randomly available. Such trees may be prominent landmarks and the roosts may be easier to access. Thus, bats switching between roosts could easily identify a particular roost tree.

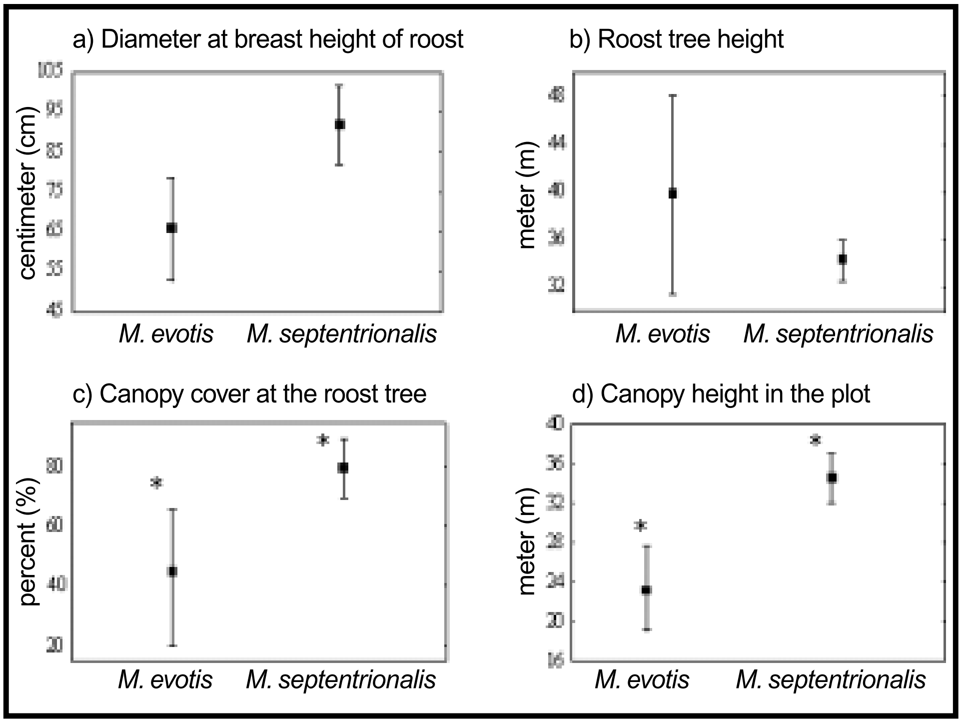


Figure 3a-d. Selected characteristics (± SE) of roost trees used by *M. septentrionalis* (n=9) and *M. evotis* (n=5). 3 *M. evotis* and 4 *M. septentrionalis* individuals led to 14 roost trees in total. Asterisks indicate significant differences (Mann Whitney U-test).

Vonhof & Barclay (1996) suggested that species' differences in roost-tree selection are minimal as all temperate-zone bats are under the same selective pressures in choosing tree roost-sites. While similar constraints may result in general similarities between species' roost trees, there is evidence of species-specific roost requirements as found by Foster & Kurta (1999). When comparing the roosts of *M. sodalis* (the Indiana bat, an endangered species) to *M. septentrionalis* (which is quite common in Michigan), they found *M. sodalis* more variable in its roost selection. They also found that *M. septentrionalis* differed from other forest-dwelling bats because the species commonly roosted in live trees under relatively high canopy cover (also Sasse & Pekins 1996). In Eastern BC, *M. septentrionalis* is listed as a "vulnerable" species and uncommonly encountered, whereas *M. evotis*, the western long-eared bat is more common and believed to have a broad roosting niche.

Our results indicate that the types of forest stands selected by *M. septentrionalis* differ from those used by *M. evotis* in canopy height and closure. *M. septentrionalis* was only caught in or near the national parks (Caceres 1998), which provide a large area of mature cedar-hemlock forest. Most *M. septentrionalis* roost trees were found within these forests. As expected, *M. evotis* showed greater flexibility in roost types (see also Vonhof & Barclay 1997) as we found it throughout the study area in trees, crevices and tree stumps. The fact that one *M. evotis* captured in Mount Revelstoke National Park used a rock-crevice roost suggests that the consistent use of trees by *M. septentrionalis* was not due to the lack of alternate roost-types. It is evident that *M. septentrionalis* is dependent on trees and forests for roosting (Foster & Kurta 1999, Sasse & Pekins 1996). Thus, the rarer species, *M. septentrionalis* may not be as flexible in its roosting selection as *M. evotis*, showing variability similar to that found by Foster & Kurta (1999) between *M. sodalis* and *M. septentrionalis*.

Foster & Kurta (1999) suggest interspecific interactions can play a role in roost availability in regions where suitable roosts are limited. It is possible *M. septentrionalis* is encountering similar constraints in regions outside the National Parks of the interior wet-belt, where large diameter climax trees are less abundant. The undisturbed old-growth forests of the National Parks may offer greater roosting opportunities for *M. septentrionalis* and partially contribute to this rare species local abundance. However, further research is necessary given the limited sample size of this study.

M. Carolina Caceres, Program Advisor- Conservation Organizations, Canadian Wildlife Service, Environment Canada. Tel: (819) 997-4284; ssc_iucn@ec.gc.ca

R.M.R. Barclay, Professor, Dept. of Biological Sciences, University of Calgary; barclay@ucalgary.ca

REFERENCES CITED

Caceres, M.C. 1998. *The summer ecology of Myotis species bats in the interior wet-belt of British Columbia*. M.Sc. Thesis. University of Calgary, Calgary, Alberta. 102 pp.

Foster, R.W., and A. Kurta. 1999. Roosting ecology of the Northern bat (*Myotis septentrionalis*) and comparisons with the endangered Indiana bat (*Myotis sodalis*). *J. Mammal.* 80: 659-672.

Kunz, T.H. 1982. Roosting ecology of bats. pp. 1-55 *In: Ecology of Bats*. T.H. Kunz (ed). Plenum Press, New York, 425 pp.

Nagorsen, D.W., and R. M. Brigham. 1993. *Bats of British Columbia: Royal British Columbia museum handbook*. University of British Columbia Press, Vancouver, Canada.

Sasse, D.B., and P.J. Pekins. 1996. Summer roosting ecology of Northern Long-eared Bats (*Myotis septentrionalis*) in the White Mountain National Forest. pp. 91-101 *In: Bats and forest symposium*. R.M.R. Barclay and R.M. Brigham (eds). Research Branch, British Columbia Ministry of Forests, Victoria, British Columbia. Working Paper 23/1996, 292pp.

Vonhof, M.J., and R.M.R. Barclay. 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. *Can. J. Zool.* 74: 1797-1805.

Vonhof, M.J., and R.M.R. Barclay. 1997. Use of tree stumps as roosts by the Western Long-eared Bat. *J. Wildl. Manage.* 61: 674-684.

BADGERS:
Can We Dig Them Out of this Hole?

An Update on the Population Ecology and Conservation of Badgers in Southeast British Columbia

N. J. Newhouse and T. A. Kinley

TIM MCALLISTER

American Badger

Badgers, the digging dynamos of western North America, have frequently fallen through the cracks of wildlife management planning. Often classified as 'vermin', these nocturnal carnivores have been largely ignored. However, recent initiatives have put badgers on the wildlife management radar screen. In 1995, Canada's first-ever badger radiotelemetry research project, the East Kootenay Badger Project, was initiated in partnership with Kootenay National Park (KNP).

In British Columbia, American badgers occur in the south-central and southeast portions of the province, the northwestern limit of their distribution. The subspecies present here (*Taxidea taxus jeffersonii*) is red-listed ("threatened or endangered") in British Columbia and classified as "endangered" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2001).

The objectives of the East Kootenay Badger Project are to acquire information on home range, diet, and habitat use, and to use this information in undertaking conservation measures that will ensure the maintenance of a viable population.

METHODS

Our study area is in the East Kootenay region, which includes the upper Columbia and Kootenay rivers in the Rocky and Purcell mountains and the Rocky Mountain Trench.

We trapped and surgically implanted badgers with intraperitoneal radiotransmitters. Samples of blood, feces, and hair, and an upper premolar tooth were collected. Radiotelemetry monitoring occurred year-round, typically twice a month in summer and monthly in winter. We located animals aerially; then, when time and badger activity permitted, employed ground-based telemetry to locate badgers in their burrows. Pacific Identifications Inc., Victoria, assessed diet based on bone fragments in stomach and feces of study animals and roadkilled untagged badgers. To allow comparisons with other studies, we calculated home ranges with the minimum convex polygon method, using *Calhome* (Kie et al. 1994). We present a subsample of our results, spanning 1996-2001.

RESULTS

BADGER CAPTURE AND STATUS SUMMARY

Of 31 badgers radiotagged, 13 died, 7 had transmitter failure, and 11 are still being monitored as of June 2002. The average annual mortality was 23% among adults and 45% among juveniles (<1 yr). Causes of mortality included roadkill (3), probable predation by cougar (2), train kill (1), old age (1), predation by bobcat (1), surgery-related (1), and unknown (4). We also received reports of untagged badgers being roadkilled, trapped, and shot.

Table 1. Minimum litter sizes of radiotagged badgers, southeast British Columbia, 1996-2001. Females were checked for kits 6 to 10 weeks post-parturition, when kits became active above ground. Blanks indicate female was not tagged or monitored that year.

Badger	1996	1997	1998	1999	2000	2001
F1	0	0	0	0		
F3	0	0	0	0		
F5		0				
F7		1	0	1	1	
F14					2	2
F22						1
F27					0	
F29					2	

REPRODUCTIVE SUCCESS

Eight adult females have been monitored for ≥1 summer each (Table 1). Of the 7 litters actually recorded, 3 were single kits from one badger. Maximum observed litter size has been 2, though some kits may have died before being observed. The public has reported litter sizes of up to 4 kits.

HOME RANGES

As of 2000, home ranges were much larger than those found elsewhere (Table 2). Another subsample of badgers recently radiotagged at southern end of the study area appears to have considerably smaller ranges, but data are not yet complete.

HABITAT USE

Radiotagged badgers have collectively used all 5 of the biogeoclimatic zones in the study area (n = 847 telemetry locations to August 2000). These include, in ascending elevational order, the Ponderosa Pine (PP), Interior Douglas-fir (IDF), Montane Spruce (MS), Engelmann Spruce – Subalpine Fir (ESSF), and Alpine Tundra (AT) zones. Habitat use has been concentrated at lower elevations, with 27% of locations in the PP and 64% in the IDF, and all but 1 badger occurring all or part of the time in the IDF. Individual variation has been apparent, with 1 animal being entirely resident in the MS and ESSF (2 years of data), and at least 2 males making a total of 4 trips from the IDF at about 800 m to the AT at 2200 to 2400 m in July, September, and November.

Among cover types, burrows occurred most commonly in open range (46%) and upland (mostly open) forests (25%, *n* = 518 ground-based telemetry locations). Most of the remaining locations were fields, golf courses and roadsides.

DIET

Fecal and stomach samples (n = 52) have included Columbian ground squirrels (24), insects (7), red-backed voles (4), sparrows (2), common loons (2), rabbit or hare (1), northern pocket gopher (1), sucker (1), salmonid (1), frog or toad (1), long-toed salamander (1), and unidentified remains (5), or were empty (11).

DISCUSSION AND MANAGEMENT IMPLICATIONS

Some aspects of badger ecology in the East Kootenay mirror other regions of North America, including predominant use of non-forested and open-forest habitats, a varied diet dominated by ground squirrels, and relatively high adult survivorship. However, our results, including those from an earlier paper on their general ecology (Newhouse and

Table 2. Comparison of mean home ranges (km^2) of adult American badgers, southeast British Columbia, 1996 – 2000, to those found in other studies, based on 100% minimum convex polygon (MCP) method.

Study Location	Home Range (km^2) Female *(n)*	Male *(n)*	Source
Idaho	2 *(7)*	2 *(3)*	Messick and Hornocker (1981)
Wyoming	3 *(15)*	8 *(18)*	Minta (1993)
Illinois	13 *(7)*	44 *(6)*	Warner and Ver Steeg (1995)
British Columbia	51 *(4)*	450 *(5)*	this study

TIM MCALLISTER

American Badger Burrow

Kinley 2002) differ from other studies in showing large home ranges, low population density, low reproductive success, and presence within diverse habitat types.

Anecdotal reports indicate that badgers were more abundant in the Rocky Mountain Trench over the past 80 years, with populations almost certainly greater than the 60 breeding adults now estimated to occur in the entire East Kootenay (N. Newhouse, unpublished data). This, in combination with badger habitat modeling (Apps et al. 2001) indicating extensive areas of suitable habitat outside of areas of known badger occurrence, suggests that habitat exists to support a higher population. In light of this, there are at least two possible explanations, prey abundance and mortality rate, for the current observed low numbers and large home ranges.

Badgers clearly rely on Columbian ground squirrels as a significant prey base. Habitat for ground squirrels is decreasing as a result of both urbanization and forest in-growth into naturally open habitat at low elevations, a result of fire suppression. At middle elevations, temporary, rotating habitat for ground squirrels and badgers is created by forest harvesting, but these cutblocks may provide relatively minor benefits because they are disjunct, not all are colonized by ground squirrels, and may lose their value as ground squirrel habitat more quickly than did historic burns, because cutblocks are immediately replanted with trees. If temporary habitat creation at middle elevations is insufficient to compensate for losses at low elevations, then low prey availability may regulate the badger population and necessitate large home ranges. Future research to address this uncertainty could focus on the habitat selection and population dynamics of Columbian ground squirrels, potential residency of female badgers in the alpine tundra zone, and responses by badgers to habitat restoration within fire-maintained ecosystems.

Alternatively (or perhaps additionally) historic and on-going high badger mortality coupled with low natality may explain low population numbers. Our research shows that badgers in southern BC are subject to roadkill, predation, trapping, and shooting. High mortality relative to reproductive success would continue to suppress population numbers, particularly if population densities are low enough to reduce breeding opportunities. Education efforts should be aimed at improving stewardship and reducing human-caused mortality. Future research should be directed at identifying the value of population augmentation through translocation.

Badgers may be mistakenly assumed to be abundant in all jurisdictions, given that they are relatively abundant within the core of their North American range,

TIM MCALLISTER

American Badger Near Wolf Creek, B.C.

are commonly seen roadkilled, and can create burrows over large areas. The results of this study are likely to have significance in many jurisdictions, since about half of the states and provinces in which badgers occur are along a range limit. If the demography and habitat threats found in the East Kootenay are reflected elsewhere along the species' distributional limit, then other populations or even subspecies may be at risk. Cost-effective methods of determining badger status without intensive research are under development, such as sampling DNA with hair-snagging tools.

Based on the current research, management practices within KNP and adjacent Crown and private lands could include:

- -increased use of culverts under highways that cross high quality badger habitat;
- -protection of prey populations, especially Columbian ground squirrel colonies;
- -continued use of interpretation to dispel badger myths and encourage ecological understanding, particularly when badgers are present in park campgrounds;
- -gazetting federal Crown lots in the Radium Hot Springs area into KNP;
- -restoring or creating habitat by re-establishing historic fire regimes to create continuous, non-forested habitat;
- -identifying and conserving suitable habitat; and,
- -translocating badgers to augment low populations.

ACKNOWLEDGEMENTS

We thank L. Ingham, A. Dibb, M. Panian, A. Levesque and M. Belcher for administrative and technical support, I. Parfitt for GIS mapping, T. McAllister and R. Klafki for field work, and S. Crockford for prey identification. Financial, technical, and administrative support were provided by the Columbia Basin Fish and Wildlife Compensation Program, Parks Canada Species At Risk Fund, Forest Renewal British Columbia, East Kootenay Environmental Society, Tembec Industries Inc, BC Parks, and the Invermere Veterinary Hospital.

Nancy Newhouse and Trevor Kinley are senior wildlife biologists with Sylvan Consulting Ltd., Invermere, B.C. Tel: (250) 342-3205; sylvan@rockies.net.

LITERATURE CITED

Apps, C.D., N.J. Newhouse, and T.A. Kinley. 2001. *Habitat associations of American badgers in southeast British Columbia*. Prepared for Columbia Basin Fish and Wildlife Compensation Program, Nelson, British Columbia. 22pp.

COSEWIC. 2001. http://www.cosewic.gc.ca/eng/sct1/index_e.htm

Kie, J.G., J.A. Baldwin, and C.J. Evans. 1994. *Calhome home range analysis program electronic user's manual*. U.S. Forest Service, Pacific Southwest Research Station, Fresno, California.

Messick, J.P., and M.G. Hornocker. 1981. Ecology of the badger in southwestern Idaho. *Wildlife Monographs* 76. 53pp.

Minta, S.C. 1993. Sexual differences in spatio-temporal interaction among badgers. *Oecologia* 96:402-409.

Newhouse, N.J., and T.A. Kinley. 2002. Progress report. *Annual update on population ecology of badgers in the East Kootenay*. Prepared for Columbia Basin Fish and Wildlife Compensation Program, Nelson; Forest Renewal British Columbia, Cranbrook; East Kootenay Environmental Society, Kimberley; Tembec Industries, Cranbrook; and Parks Canada, Radium Hot Springs, British Columbia. 8pp.

Warner, R.E., and B. Ver Steeg. 1995. *Illinois badger studies*. Division of Wildlife Resources, Illinois Department of Natural Resources, Springfield, Illinois. 163pp.

BADGER

Outreach and Education

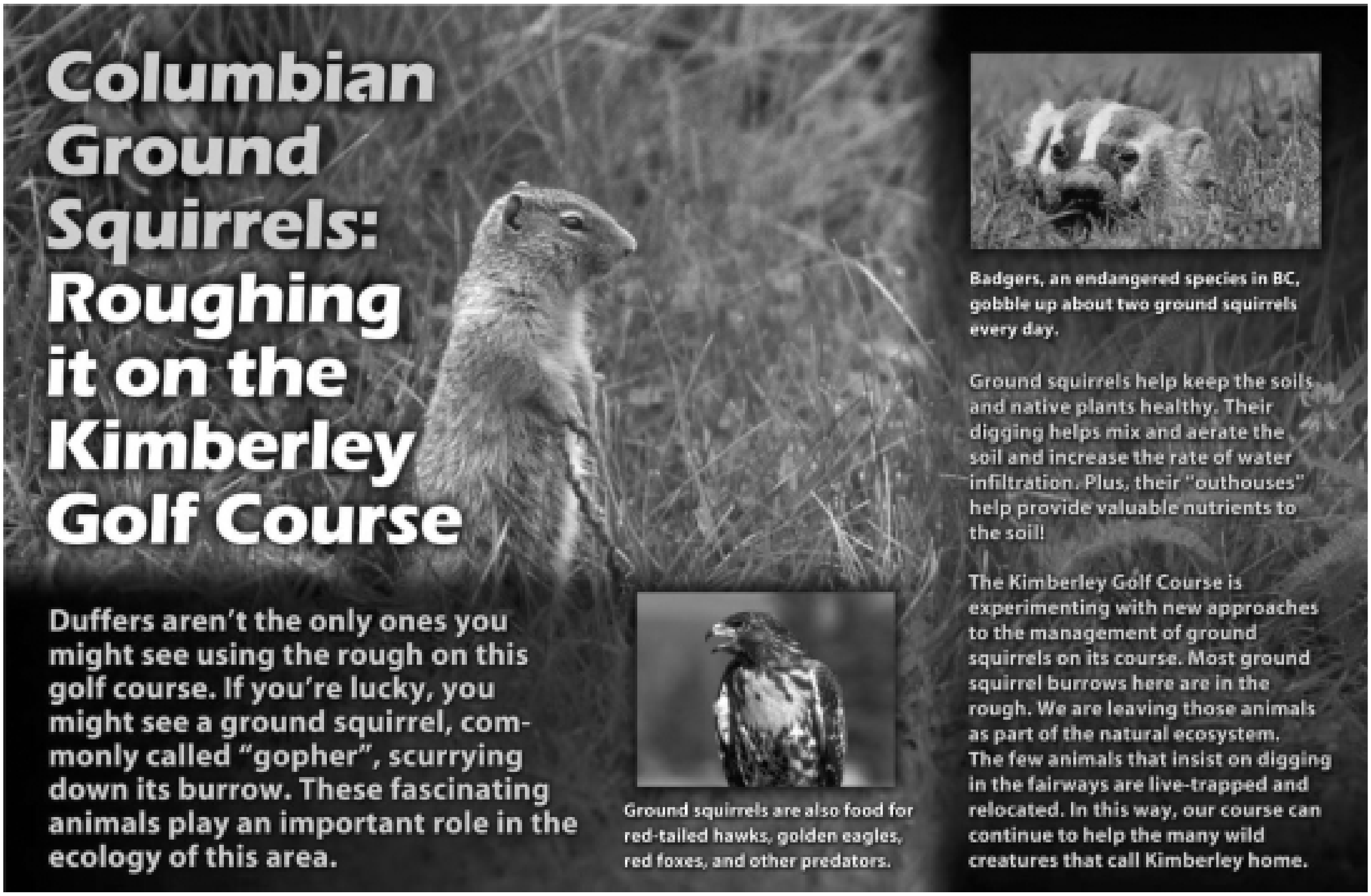
Outreach and education in the East Kootenay Badger Project are achieved through multiple venues including brochures, newspapers, radio, television, magazines, and website development. Private stewardship initiatives are being undertaken with ranchers and golf course owners.

Landowners became strongly committed to badger conservation through handling immobilized badgers caught on their property, and subsequently learning where these badgers traveled and what fates they met. Two different signs identifying private properties as badger habitat and acknowledging the landowner's support of the East Kootenay Badger Project (*upper left photo*), were developed and installed on 17 properties.

An initiative to promote conservation of ground squirrels and badgers on golf courses was developed in cooperation with the Kimberley Golf Course. An interpretive sign explaining the ecological benefits of ground squirrels to soil and predators, including badgers, was developed and installed (*photos - right and below*).

A badger website developed by Kootenay National Park will be completed by summer 2002 at http://www.worldweb.com/ParksCanada-Kootenay.

N. Newhouse & T. Kinley; sylvan@rockies.net



Research High

TOM HERMAN

Blanding's Turtle

SPECIES AT RISK MANAGEMENT IN KEJIMKUJIK NATIONAL PARK AND NATIONAL HISTORIC SITE

The Species at Risk management program at Kejimkujik has been a long-standing one. The significance of rare species such as the Blanding's turtle, coastal plain flora, and piping plover has been recognized in Nova Scotia for years, and the park's ecosystem conservation plan previously served as a basis for study and management of these species. For example, digitally recorded and georeferenced records for every Blanding's turtle observed in the vicinity of Kejimkujik spanning a period of several decades offers unequalled opportunities to analyse the population. Part of the success at Kejimkujik has been as a result of cooperation between the Park and the Government of Nova Scotia and several maritime universities, thus advancing a collaborative ecological approach. Also, the park is also represented on Blanding's Turtle, Coastal Plain Flora, and Piping Plover Recovery Teams, further strengthening the teamwork approach to species at risk management.

Recently, however, the Species at Risk research and management program at Kejimkujik National Park and National Historic Site has moved into high gear with the implementation of a variety of studies, ongoing monitoring, and the development of recovery plans for two species, the Blanding's turtle and water pennywort. In addition, upcoming activities of the Species at Risk program at Kejimkujik include protocol development and an assessment of juvenile Blanding's turtle populations in the park; an evaluation of Blanding's populations in Grafton Lake as part of a ecosystem restoration initiative; a broad based survey to find undiscovered turtle habitat in Kejimkujik's backcountry lakes and streams; a biogeographic mapping project to document habitat variables for coastal plain flora and Blanding's turtles; a pilot project to restore nesting habitat for piping plover, and continued assessment of southern flying squirrel ecology.

Extension and education also play a significant role in the Species at Risk program. For example, in collaboration with the Southwest Nova Biosphere Reserve Association (SNBRA), a traveling species at risk stewardship exhibit and web pages have been developed and used at a variety of schools and museum venues in western Nova Scotia. Kejimkujik staff are working with Parks Canada Headquarters personnel on a 3-D web page. The park is also participating in a partnership with the Biosphere Reserve Association, the Queensland Australia Department of Education, and the Smithsonian Institution to develop an educational web page including species at risk in Nova Scotia.

Cliff Drysdale, Manager: Ecosystem Science and Species at Risk, cliff_drysdale@pch.gc.ca

DEVELOPING WOOD BISON HABITAT MODELS

Wood Bison (*Bison bison athabascae*), the largest native land animal in North America, is currently listed by COSEWIC as *threatened* in Canada. The goals of the Wood Bison Recovery Team are to establish at least four free-ranging, discrete, disease-free and viable populations, each containing a minimum of 400 animals. Further, the issue of critical habitat is identified in the current recovery plan.

Parks Canada, Wood Buffalo and Elk Island National Parks, the Government of the Northwest Territories, the Wood Bison Recovery Team and the University of Alberta are working on a new project to quantify Wood Bison habitat requirements. Multi-scale models of suitable habitat will be created using remote sensing and G.I.S. technology. Areas to be studied include Wood Buffalo National Park, the Slave River Lowlands and the Mackenzie Bison Sanctuary. LandSat 7 ETM+ imagery will be used for primary vegetation classification; ancillary data consisting of digital terrain models, high-resolution and radar imagery will help refine the classification. This model will have province-wide and perhaps national applicability. Vegetation classifications will be used in conjunction with bison positional data (telemetry, GPS and aerial survey data) in spatial and statistical habitat analysis. The resulting habitat model(s) will assist in defining critical habitats and developing reintroduction guidelines.

Forage and dietary requirements for wood bison have been studied and are known. What is missing is knowledge of the spatial relationships between the position, size, juxtaposition of habitat patches in a landscape, and the importance of these relationships.

This study was initiated in 2000, and completion is anticipated for 2003. To date, preliminary analysis of satellite imagery has been completed. Model development is expected to begin fall 2002.

Olaf Jensen, ojensen@ualberta.ca

RECOVERY PLANNING FOR THE ENDANGERED SHARP-TAILED SNAKE, *Contia tenuis*

The sharp-tailed snake is a small, harmless, secretive snake found predominantly in the Southern Gulf Islands of BC. Parks Canada joined the recovery effort last year as several sites acquired for the new Gulf Islands National Park Reserve have strong potential to offer suitable habitat for this endangered species. Both a recovery team and a draft recovery strategy are in place.

Sharp-tailed snakes have recently been confirmed in only 4 locations, all on the Gulf Islands and southern Vancouver Island. This species is extremely difficult to find and more extensive searches are required both to confirm the presence or absence of snakes from previous locations and to determine whether other populations exist. This year, with funding from the Parks Canada Species at Risk Recovery Fund, researchers will identify and assess potential sharp-tailed snake habitats within the proposed Gulf Islands National Park Reserve using a combination of air photo and map interpretation and ground assessment. The second phase will involve the installation of artificial cover-objects (to attract the snakes) and non-destructive searches of natural cover.

Brian Reader, Species at Risk Ecologist, brian_reader@pch.gc.ca


KRISTINA OVASKA

Sharp-tailed snake (*Contia tenuis*)

Adults, measuring approximately 30 centimetres long and the thickness of a pencil, are a chestnut brown colour, with darker sides and dark mask over the eyes. Sharp-tailed snakes are easily confused with young garter snakes, but can be distinguished by the distinctive pattern of black and white banding on the belly, and by the sharp, thorn-like tail tip.

Use of spring migration stopover habitat by trumpeter swans in southern Alberta.

TRUMPETER SWANS

Jalene M. LaMontagne

B. ANDERSON

Trumpeter Swan

The trumpeter swan (*Cygnus buccinator*) is the largest waterfowl species in North America (Mitchell 1994). They once bred throughout North America; but were nearly hunted to extinction in the early 1900's (Coale 1915). Trumpeter swans were classified *endangered* in Canada until 1978 (Mackay 1978). Nationally, they are considered *not at risk* (COSEWIC 2001), however, in all provinces where they occur they are listed as *at risk*, *may be at risk*, or *sensitive* (Canadian Endangered Species Conservation Council 2001). In Alberta they are currently *at risk*, and are classified as *threatened* under the Wildlife Act (Anonymous 2000).

Most research on trumpeter swan habitat use has been conducted in breeding and wintering areas (Shea 1979, Holton 1982, Squires and Anderson 1997); however, little is known of their use of migration habitat. Many waterfowl species gather energy required for successful reproduction during spring migration (Gammonley and Heitmeyer 1990). Breeding trumpeter swans likely rely on energy reserves since nest construction begins while ponds are ice-covered, and egg-laying occurs shortly after ponds open (Holton 1982, Mitchell 1994).

Knowledge of the habitat preferences of migrating trumpeter swans is important to Parks Canada for three reasons: (1) national parks (e.g., Waterton, Elk Island) are used during migration, so parks managers need to be aware of spring habitat requirements; (2) detailed species-habitat relationships can help build more accurate habitat suitability models; and, (3) migration stopover habitat can be linked with ecosystem-based initiatives like benchmark lakes.

During spring migration, trumpeter swans use specific ponds, moving in stages through stopover areas (G. Beyersbergen, Canadian Wildlife Service, pers. comm.). This study examined: (1) time-budgets of migrating trumpeter swans at stopover ponds, and, (2) characteristics of ponds consistently used by trumpeter swans. The following is an excerpt from a larger study of trumpeter swan habitat use during spring migration (LaMontagne 2000, LaMontagne et al. 2001).

METHODS

The study area was located ~50 km west of Calgary (51°05'N, 114°30'W to 51°09'N, 114°42'W), in an area of the Rocky Mountain foothills with numerous ponds. Ranching is the main land-use practice.

In spring 1999 and 2000, 13 study ponds were visited daily. From each pond with swans present, 10 swans were randomly selected and each individual observed for 10 minutes. All activities were recorded and the proportion of time spent foraging, resting (sleeping or loafing), preening, and in locomotion (swimming, walking) was calculated. The behaviour of adults and cygnets did not differ (LaMontagne et al. 2001), therefore average values are presented for each year.

To determine pond properties consistent with habitat use, the ponds were separated into three groups (consistent use (n=4), intermediate use (n=4), and unused (n=5)) based on observed use and anecdotal history (G. Beyersbergen, pers. comm.) (Table 1). During spring and summer 1999, pond properties including area available for foraging (<1 m deep; Holton 1982), pH, chlorophyll a, salinity, and tuber and rhizome biomass were measured. Statistical analyses (Multivariate Analysis of Variance (MANOVA), and Analysis of Variance (ANOVA)) were used to determine factors separating the pond-use categories. Reported values are means ± standard errors.

Table 1: Classification of southern Alberta ponds by migratory trumpeter swan use, and mean (standard error) pond characteristics. Pond characteristics with a * denote significant ANOVA tests (P<0.05). Pond classes with like letters are not significantly different, determined via Tukey tests.

Characteristic	Pond Use Category: Consistent (n=4)	Intermittent (n=4)	Unused (n=5)
Total Swan-Days Used[1]			
1999	196 – 411	2 – 51	0 – 32
2000	100 – 441	42 – 792[2]	0 – 6
Open water area (ha)	4.078 (1.784)	3.999 (1.727)	1.685 (0.566)
Area <1 m deep (ha)	2.335 (0.518)	2.168 (0.658)	1.431 (0.460)
pH	8.90 (0.24)	8.75 (0.33)	8.68 (0.28)
Chlorophyll a ($mg \cdot L^{-1}$)	2.79 (0.88)	2.85 (0.77)	1.52 (0.68)
Salinity (ppt)*	0.84 (0.13)a	0.39 (0.04)b	0.68 (0.06)ab
Rhizome + Tuber Dry Mass ($g \cdot m^{-2}$)*	3.96 (0.62)a	1.24 (0.44)b	1.16 (0.62)b

[1] 1 swan-day = 1 swan present for 1 day

[2] One pond had high use in 2000 due to a cold period when all other ponds refroze (more detailed analysis in LaMontagne 2000).

RESULTS AND DISCUSSION

Trumpeter swans were observed to use ponds in the study area in April and May of each year (Table 2). The total number of swan-days of use was higher in 2000, although they were present for fewer calendar days. The peak number of swans remained higher for longer in 2000 than in 1999 (i.e., 9 days with >120 swans counted in 2000, 3 days in 1999; LaMontagne 2000).

Trumpeter swans spent most of their time foraging and resting (Figure 1). Variation between years was consistent with differences in ambient temperatures; 2000 was colder, and some foraging time was traded-off for increased rest time (see LaMontagne et al. 2001). This cold period was also the time of peak swan numbers in 2000.

The mean proportion of time allocated to foraging by trumpeter swans in the study area was 0.490 ± 0.018. This is slightly greater than the spring value for non-migratory trumpeter swans in the greater Yellowstone area (0.445 ± 0.021; Squires and Anderson 1997), and much greater than in their common wintering area (0.296 ± 0.027; Squires and Anderson 1997). The similarity in spring time-budgets suggests that both migratory and non-migratory swans need to build up energy reserves before breeding. There is no information on trumpeter swan patterns of mass gain in spring, however, food abundance is likely reduced overwinter, therefore increased foraging time in spring by nonmigratory swans may also be related to higher search times. The migratory trumpeter swans take up to two months to move to breeding areas in spring, allowing considerable time for foraging enroute (Mitchell 1994). This suggests that either stopover sites are rich in food (Shea 1979) and worth exploiting, and/or that swans must stay to replenish energy lost during migration.

Table 2: Period of time that trumpeter swans were present in the study area west of Calgary in 1999 and 2000.

Year	Time Period With Swans Present	Number of Days with Swans Present	Total # Swan-Days
1999	7 April – 21 May	36	1300
2000	10 April – 11 May	32	2002

Within spring stopover areas, trumpeter swans preferred ponds with both a higher biomass of tubers and rhizomes, and a higher salinity compared to intermediate use and unused ponds (Table 1). This was not surprising, given that their dominant activity was foraging, and that the tuber producing macrophyte (aquatic plant), *Potamogeton pectinatus* is restricted to waters with high ion concentrations (Hutchinson 1975). In breeding and wintering areas, trumpeter swans select ponds and slow moving rivers with high

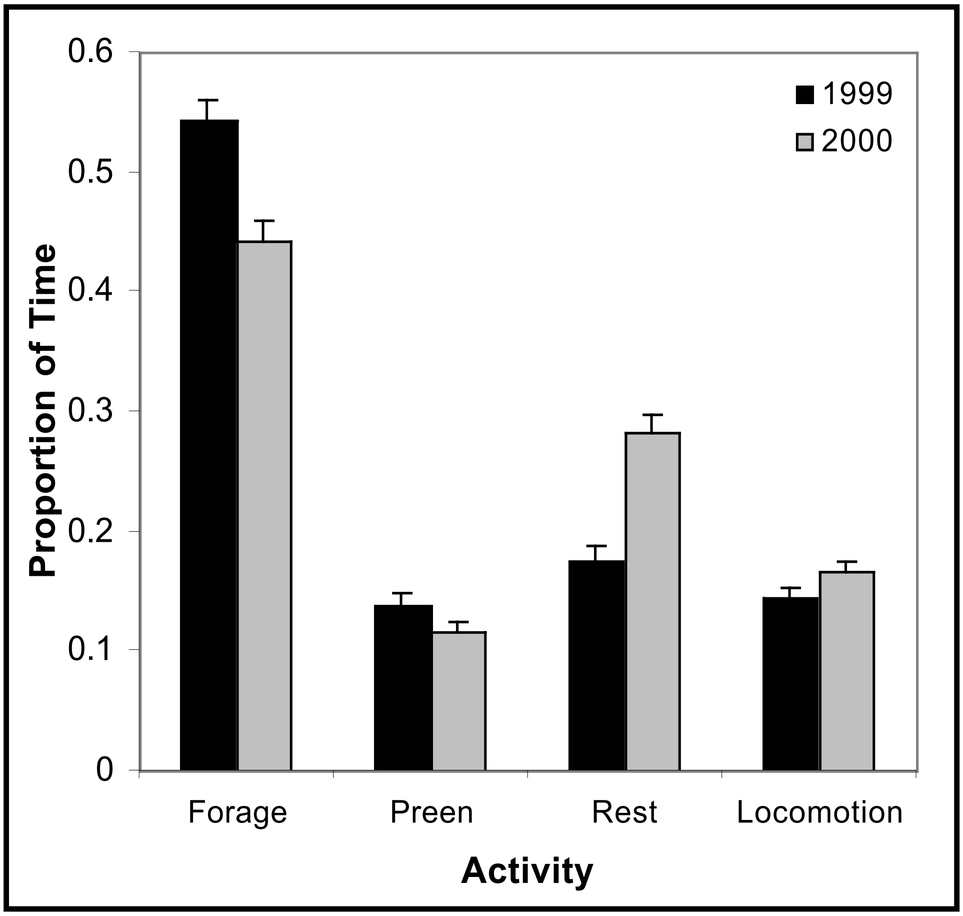


Figure 1: Mean (standard error) proportions of time spent in various activities by trumpeter swans in a migration stopover area west of Calgary, Alberta in spring 1999 (n=542) and 2000 (n=605). 'n' is the number of observations conducted.

macrophyte, and tuber and rhizome (underground macrophyte overwintering structures) biomass (Shea 1979, Holton 1982).

To date, migration stopover areas have been largely overlooked in the trumpeter swan literature. I have shown that trumpeter swans select stopover areas based on forage availability and spend substantial time foraging while in these areas. Sustainability of forage resources in consistently used ponds will be key to ensuring successful reproduction and continued population increase. Study results can be used in active pond management to ensure that the habitat preferences and requirements of trumpeter swans are met.

Jalene LaMontagne is currently a Ph.D. student at the University of Alberta. Tel: (780) 492-4893; jalene.lamontagne@ualberta.ca.

ACKNOWLEDGEMENTS:

This research was conducted as part of J.M. LaMontagne's graduate work supervised by Dr. R.M.R. Barclay and Dr. L.J. Jackson at the University of Calgary, and was funded by NSERC, a University of Calgary Thesis Research Grant, the Ellis Bird Farm graduate scholarship, and Challenge Grants in Biodiversity.

REFERENCES:

Anonymous. 2000. *The General Status of Alberta Wild Species 2000*. Alberta Environment. Pub. No. I/023.

Canadian Endangered Species Conservation Council. 2001. *Wild Species 2000: The General Status of Species in Canada*. Ottawa: Minister of Public Works and Government Services Canada.

Coale, H.K. 1915. The current status of the trumpeter swan (*Olor buccinator*). *Auk* 32:82-90.

COSEWIC. 2001. *Canadian Species at Risk, November 2001*. Committee on the Status of Endangered Wildlife in Canada. 32 pp.

Gammonley, J.H., and M.E. Heitmeyer. 1990. Behaviour, body condition, and foods of buffleheads and lesser scaups during spring migration through the Klamath Basin, California. *Wilson Bulletin* 102:672-683.

Holton, G.R. 1982. *Habitat use by Trumpeter Swans in the Grande Prairie region of Alberta*. M.Sc. Thesis, University of Calgary, Calgary.

Hutchinson, G.E. 1975. *A Treatise on Limnology*, Vol. III: Limnological Botany. John Wiley & Sons, Inc., New York.

LaMontagne, J. 2000. *Use of Migratory Stopover Areas by Trumpeter Swans in Southern Alberta*. M.Sc. Thesis. University of Calgary, Calgary.

LaMontagne, J.M., R.M.R. Barclay, and L.J. Jackson. 2001. Trumpeter swan behaviour at spring-migration stopover areas in southern Alberta. *Canadian Journal of Zoology* 79: 2036-2042.

Shea, R.E. 1979. *The ecology of Trumpeter Swan in Yellowstone National Park and vicinity*. M.S. Thesis, University of Montana, Missoula.

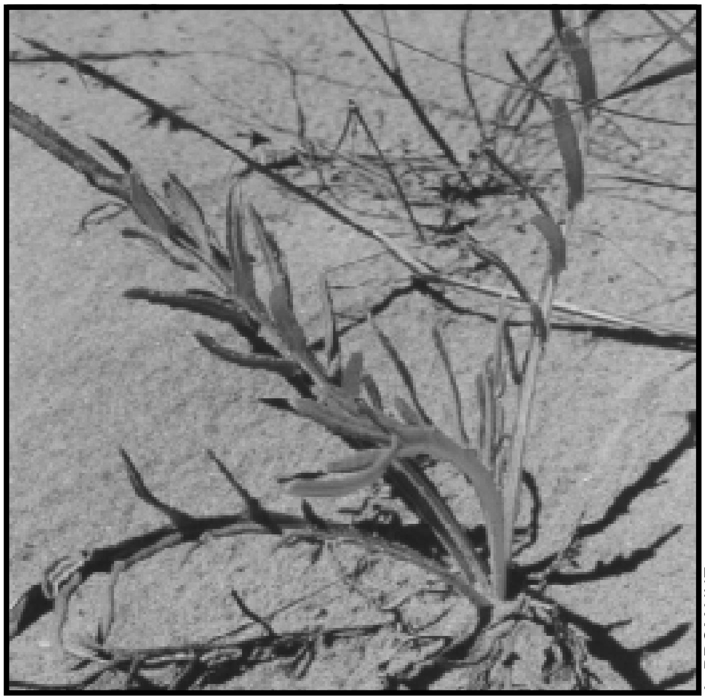
Mackay, R.H. 1978. *Status report on Trumpeter Swan (Olor buccinator) in Canada.* Status reports on endangered wildlife in Canada, vol. 1. Committee on the Status of Endangered Wildlife in Canada. Canadian Wildlife Service, Ottawa.

Mitchell, C.D. 1994. Trumpeter Swan (*Cygnus buccinator*). *In: The Birds of North America*, no.105. (A. Poole and F. Gill, Eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Squires, J.R., and S.H. Anderson. 1997. Changes in Trumpeter Swan (*Cygnus buccinator*) activities from winter to spring in the Greater Yellowstone Area. *American Midland Naturalist* 138:208-214.

Success in establishing a new colony of the endangered Pitcher's Thistle (*Cirsium pitcheri*) in Pukaskwa National Park, Ontario

Andrew Promaine


A. PROMAINE

Pitcher's Thistle

Pitcher's Thistle (*Cirsium pitcheri* Torr. and A. Gray) is endemic to the Great Lakes shoreline (White et al. 1983). The majority of its population is found along the eastern shore of Lake Michigan and the western shore of Lake Huron in open sandy environments (Gleason and Cronquist 1963). Pitcher's Thistle is classified *endangered* by the Committee on the Status of Endangered Wildlife (COSEWIC) (Maun 1999). Pitcher's Thistle plants in Pukaskwa National Park constitute a peripheral population, since there are no other records on the north shore of Lake Superior (Promaine 1999).

Mosquin (1990) suggests that this thistle is an early successor into sandy environments, and that periodic disturbance is vital to its survival. However, the plant is susceptible to habitat destruction from browsing by white-tailed deer (*Odocoileus virginianus*) (Phillips and Maun 1996), human development, and trampling (D'Ulisse and Maun 1996).

In 1986, a beaver dam burst upstream from the only population of Pitcher's Thistle known in the park. This event caused a near catastrophic decrease in the Pitcher's Thistle population from 760 individual plants in 1985, to 275 in 1986. Populations remained low (<200) for 5 years. In 1991, numbers began to rebound.

In order to prevent total species loss in the event of another catastrophic disturbance, Pukaskwa NP made efforts to establish a Pitcher's Thistle colony in a second location in the park (Mosquin 1991). Staff have since been monitoring the colonies to determine which factors influence the plant's survival rate for potential establishment within the species' range.

METHODS

In 1991, 255 seeds were collected from the original colony (Creek Beach/Oiseau Bay) in late September (Reside 1991). In early October, 207 of these seeds were planted at the new site (Middle Beach, near Hattie Cove). The Middle Beach area is composed of a series of sand dunes with a mix of associated species: poplar, creeping juniper, and grasses. The seeds were planted at three different depths: 1 cm, 2 cm, and 3 cm. Seeds were planted 20 cm apart in 10 rows over four plots. The remaining 46 seeds were frozen until the following spring (1992), when they were planted adjacent to the seeds planted the previous autumn.

RESULTS

In the spring of 1992, 27 seedlings were counted over the four plots. Seed germination was evident for both autumn planting and spring planting. Cool, moist conditions leading into the summer of 1992 appeared to be beneficial for germination both at the Middle Beach colony as well as the source population at Oiseau Bay (Reside 1992). Optimum planting depths could not be determined due to the shifting nature of the sand dunes (Reside 1992).

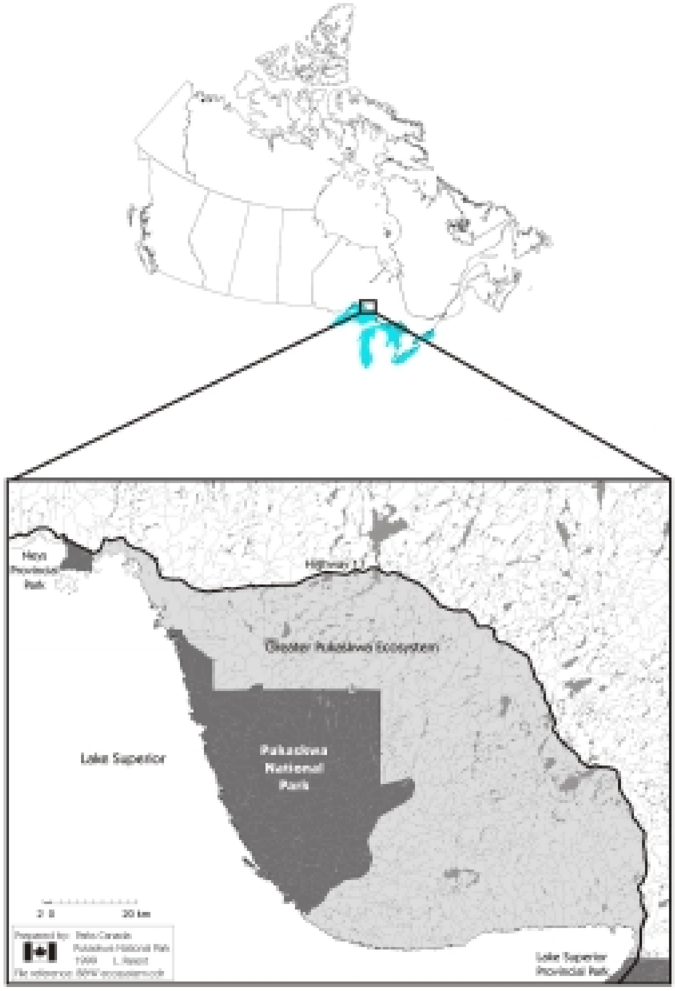


Figure 1. Location of the greater Pukaskwa ecosystem and Pukaskwa National Park, Ontario, Canada

measure of success in this effort that should afford the plant's continued survival in the park. On a side note, the original colony at Oiseau Bay has stabilized with an average 422 plants over the past 9 years.

The project results indicate that colony establishment is possible given optimum sand dune habitat. The removal or reduction of factors that threaten the thistle's survival likely contributed to the success of the colony establishment. Maun (1999) identified 5 factors limiting the plant's survival: white-tailed deer, plume moth, birds, habitat loss, and anthropogenic impacts. As Middle Beach is located in a national park, park planning can ensure habitat protection and control access, reducing potential negative impacts from anthropogenic sources. White-tailed deer have a very limited population in the area and plume moth has not been found in this colony. Birds are present, but as Maun (1999) indicates, damage is minimal. It is felt that by minimizing these limiting factors, successful establishment of Pitcher's Thistle communities is more likely. If colonial re-establishment is to occur in other areas as part of the species recovery efforts, these factors should be considered, and efforts made to mitigate them.

The population remained stable at 27 to 28 individual plants. In 1999, one of the rosettes flowered; with the resulting seed dispersal and germination, the population increased in 2000 to 109 individual plants, including 91 seedlings, 12 rosettes, and 6 flowering plants. In 2001, the population increased again to 229 individual plants with 0 seedlings, 222 rosettes, and 7 flowering plants.

DISCUSSION

The objective of the establishment of the new Pitcher's Thistle colony was to ensure the plant's survival in Pukaskwa National Park. It is key to point out that this was not a re-introduction, since the plant was not previously found along Middle Beach. However, there is a

Pitcher's Thistle (artist: Ron Sequin)

Left to Right: Rosette Stage (13" high), Seedling (3" high), Adult Plant (18" high)

ACKNOWLEDGMENTS

The results of this type of study would not have been possible without the continuing support of Pukaskwa National Park and the Warden Service, particularly Larry Vien, Lynn Parent, and Bob Reside, and the numerous staff and volunteers.

REFERENCES CITED

D'Ulisse, A., and M.A. Maun. 1996. Population ecology of *Cirsium pitcheri* on Lake Huron sand dunes: II. Survivorship of plants. *Canadian Journal of Botany* 74: 1701-1707.

Gleason, H.A., and A. Cronquist. 1963. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*. Van Nostrand Reinhold Company, New York. 810 pages.

Maun, M.A. 1999. *Update COSEWIC Status Report on Pitcher's thistle, (Cirsium pitcheri)*. Committee on the Status of Endangered Wildlife in Canada. 29pp.

Mosquin, T. 1990. *A review of monitoring procedures and management guidelines for the Beach Thistle (Cirsium pitcheri) in Pukaskwa National Park, Final Report*. Report prepared for the Canadian Parks Service, Pukaskwa National Park. 31 pages.

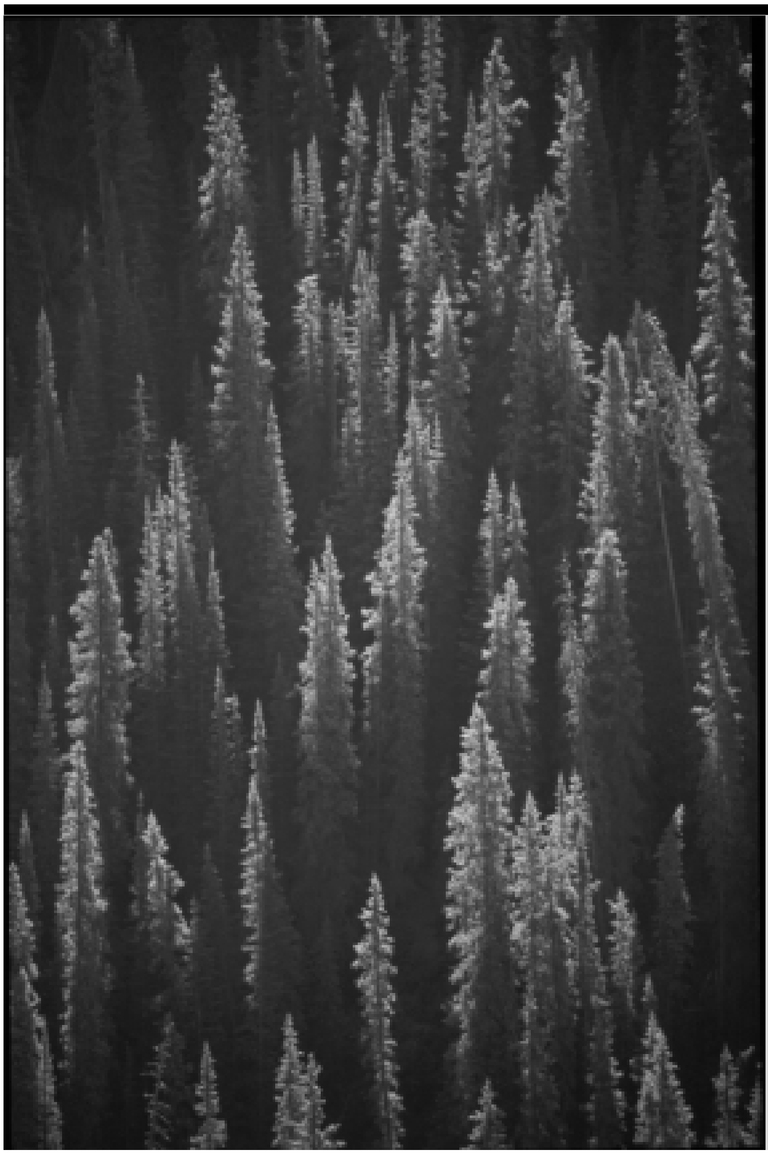
Phillips, T., and M.A. Maun. 1996. Population ecology of *Cirsium pitcheri* on Lake Huron sand dunes I. Impact of white-tailed deer. *Canadian Journal of Botany* 74: 1439-1444.

Promaine, A. 1999. Threatened species monitoring: Results of a 17-year survey of Pitcher's Thistle, *Cirsium pitcheri*, in Pukaskwa National Park, Ontario. *Canadian Field-Naturalist* 113(2): 296-298.

Reside, B. 1991. *Cirsium pitcheri Monitoring Report Pukaskwa National Park 1991*. Unpublished internal report, Warden Service, Pukaskwa National Park, Ontario.

Reside, B. 1992. *Cirsium pitcheri Monitoring Report Pukaskwa National Park 1992*. Unpublished internal report, Warden Service, Pukaskwa National Park, Ontario.

White, D.J., R.V. Maher, and C.J. Keddy. 1983. *Cirsium pitcheri* (Torr. ex Eat.) T.&G. *In:* G.W. Argus, K.M. Pryer, D.J. White, and C.J. Keddy [Eds.] 1987. *Atlas of the rare vascular plants of Ontario, Part 2*. Botany Division, National Museum of Natural Sciences, Ottawa, Canada.



A. DICKINSON

A N N O U N C E M E N T

The **Fifth International Conference on Science and the Management of Protected Areas (SAMPAA V)** will be held from May 11-16, 2003 in Victoria, BC. The overall conference theme is 'Ecosystem Based Management – Making it Work: Connecting Managers and Researchers'; a key sub-theme is the role of protected areas in species-at-risk management. Conference participants include protected area professionals, academics, researchers, managers of protected areas and habitats, members of non-governmental organizations and corporate representatives. See http://www.sampaa.org for more info, including the call for papers.

National Parks and the protection of woodland caribou: a multi-scale landscape analysis

M. Manseau, A. Fall, D. O'Brien, and M.-J. Fortin

Woodland Caribou

BACKGROUND

The creation of a new national park in the Manitoba Lowlands Natural Region is a key step towards achieving the Government of Canada's commitment to protect representative examples of each of the nation's 39 natural regions. Following a feasibility process with the province and stakeholders, park boundaries were proposed in 1996 and revisited in 1998. These encompassed two large areas of relatively undeveloped lands in the northern part of the natural region, the Long Point and Limestone Bay components (Figure 1). In light of the revised Canadian National Park Act and recommendations from the Panel on Ecological Integrity (Parks Canada 2000), discussion continued and additional boundaries analyses were conducted to assess the adequacy of protection for representative areas of the natural region (Manseau et al. 2001). Changes to the northern and southern boundaries of Long Point were proposed; these adjustments improved representation and ecological integrity objectives, but did not allow for the protection of long-ranging animal species like caribou, moose, and wolves. Therefore, we became interested in identifying areas outside the proposed park boundaries that encompassed high quality habitat, while optimizing habitat connectivity, thus facilitating movement within the habitat mosaic and enabling the persistence of large mammal populations. The initial analyses focus on woodland caribou (*Rangifer tarandus caribou*), designated as *threatened* by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

The objective of this work is to identify and assess connectivity between patches of high quality woodland caribou habitat using landscape analysis methods extended from those of Keitt et al. (1997). These analyses describe the spatial distribution of habitat patches, identify movement corridors, and rate the relative importance of individual patches to maintaining landscape connectivity. The identification of conservation priority, critical habitat patches and corridors is based on their contribution to connectivity. It will assist in refining the boundary options for the National Park and other management options that may be required for woodland caribou protection.

QUANTIFYING LANDSCAPE CONNECTIVITY

The quantification of landscape connectivity requires several steps and refers to some technical terminology that we are briefly presenting below.

LANDSCAPE GRAPHS

Habitat patches on a landscape can be represented as mathematical graphs (Harary 1969), consisting of nodes representing the habitat patches, and linear edges representing the connecting links between the patches. Connected components, or clusters, are defined as groups of patches that are linked by one or more edges. There are different ways of creating links between patches; our analyses focus on the complete graph (CG), which includes the shortest link between every pair of patches.

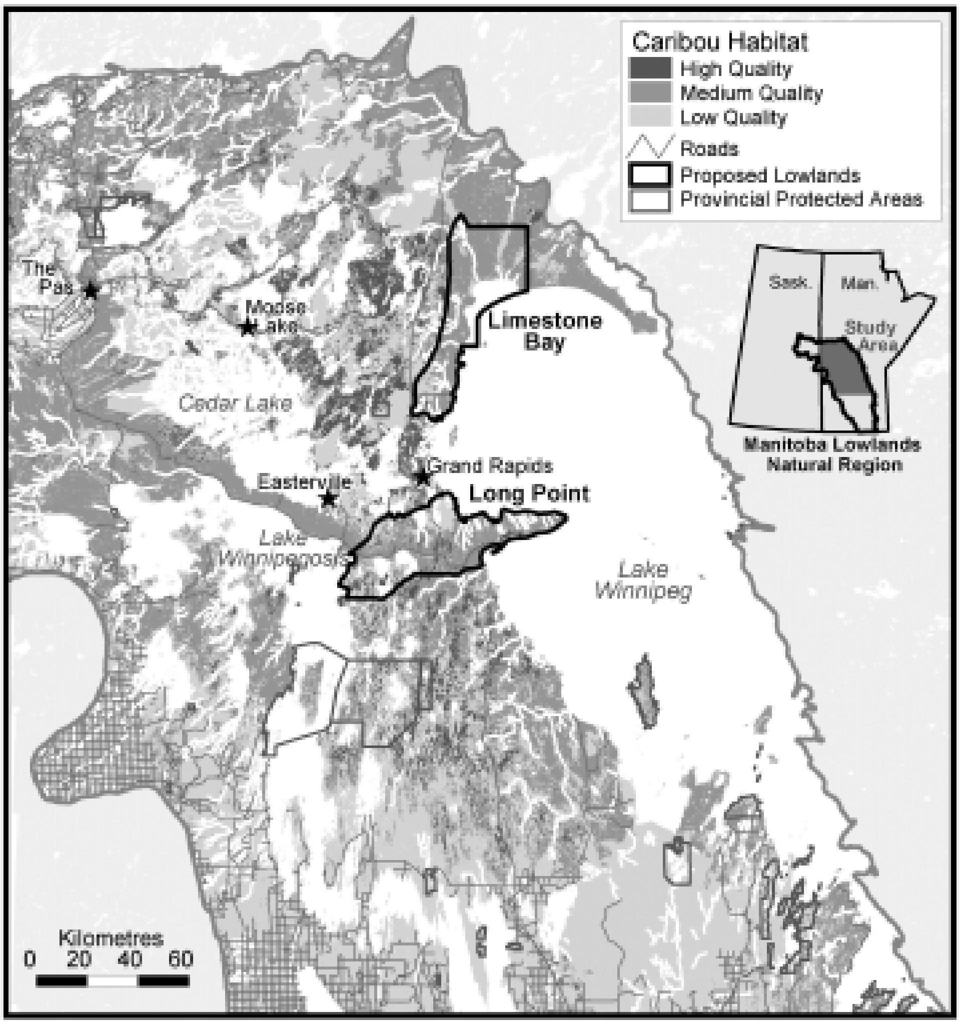


Figure 1. Distribution of woodland caribou habitat in the Manitoba Lowlands Natural Region.

GRAPH ANALYSIS

Evaluating patch connectivity involves first identifying the maximum distance at which all patches in the CG are joined, then performing a multi-scale analysis to identify critical distance thresholds at which large components of the landscape become disconnected. At each threshold, all links with a distance greater than the threshold are removed. Then, a variety of connectivity metrics are computed on the resulting graph including 1) the number of connected components (clusters) and 2) the expected cluster size (i.e., the expected size of a cluster for a randomly selected habitat cell). Connectivity is assumed to increase with decreasing number of clusters and increasing expected cluster size.

The importance of habitat patches is quantified by computing a *Patch Importance Index* for each patch on the landscape. The index corresponds to the change in expected cluster size caused by removing the patch or the entire cluster containing the patch (Equations are presented in Appendix 1). Patch importance can also be expressed in an area-weighted manner to highlight small patches with relatively high importance.

STRAIGHT-LINE VS. LEAST-COST DISTANCE

The approach of Keitt et al. (1997) assumes that the landscape between high quality patches is homogenous. However, in many wildlife management situations, the landscape is not uniformly unsuitable; rather different areas represent varying types of dispersal barriers. For example, relative to early seral forest, roads and lakes may have high dispersal impedance for terrestrial species, while mid-seral forest may have a medium dispersal impedance.

Our analyses considered distance measured in 1) straight-line space and 2) movement-cost space. In the movement-cost analysis, distance is measured as the sum of cost units that quantify impedance to movement relative to movement in high quality habitat. The measures in this cost analysis refer to “effective distance”, which is the sum of cost values along a least-cost path, not the Euclidean length of the path.

PARAMETERIZING THE MODEL

Impedance values were defined in terms of the probability of caribou moving across or into habitat patches of varying quality, relative to high quality habitat patches. The impedance value of each habitat was derived from an index of habitat selection along movement paths; this index was developed from GPS relocation data of the Owl Lake woodland caribou, Manitoba (O’Brien and Manseau 2002). The probability of caribou selecting a path across mature jack pine forest was 2 times higher than across treed muskegs, 3 times higher across mixedwood forest, and 4 times higher than across young forest, recent burns and water. A 250 m zone of influence buffer was placed around all linear features (roads, transmission lines, dams and dykes) and assigned an impedance value of 1.2 (O’Brien 2002). Minimum patch size was 100 ha. All analyses were done using Spatially Explicit Landscape Event Simulator (Fall and Fall 2001).

RESULTS

CONNECTIVITY METRICS

Landscape connectivity expressed as the number of clusters and expected cluster size is presented for the straight-line analysis (Figure 2; thresholds from

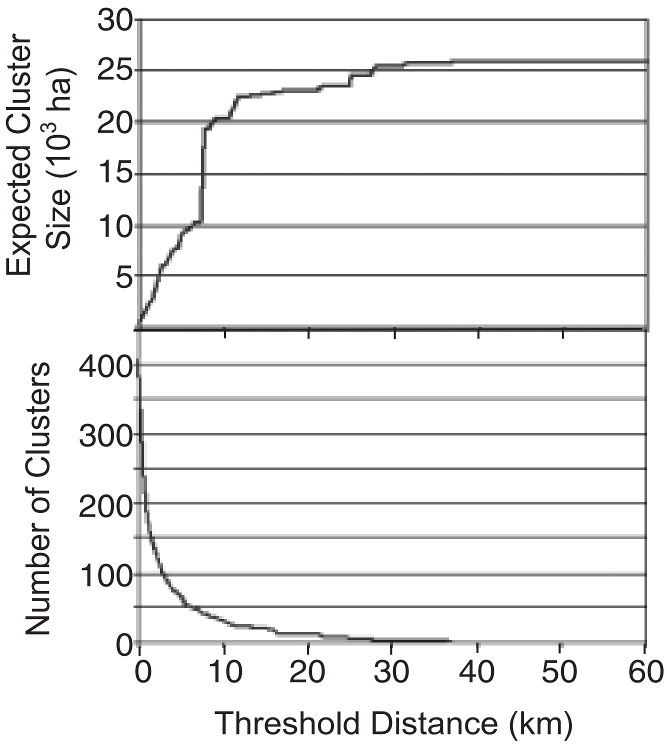


Figure 2. Expected cluster size and number of clusters of high quality caribou habitat at different threshold distances based on straight-line distances. Expected cluster size changes rapidly at fine scales of 0.5km, 2km, 2.5km and 5km, medium scales of 7.5km and 11km and coarse scales of 25km and 28km. All patches form a single cluster at a threshold distance of 37km.

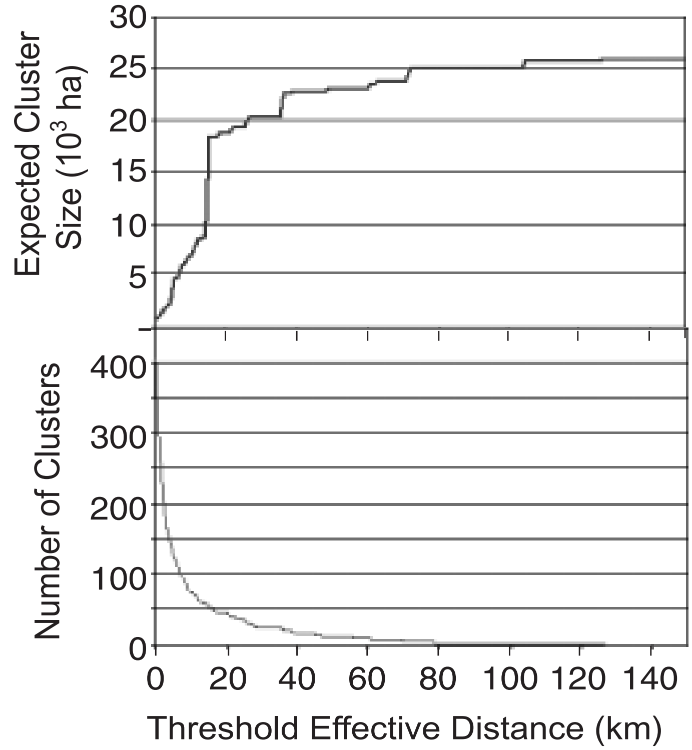


Figure 3. Expected cluster size and number of clusters of high quality caribou habitat at different threshold effective distances based on movement-cost distances. Expected cluster size changes rapidly at fine scales of 1km, 2km and 5km, medium scales of 15km and 36km and coarse scales of 64km, 72km and 106km. All patches form a single cluster at a threshold effective distance of 127km.

0-60 km, in increments of 500 m) and for the least-cost analysis (Figure 3; thresholds from 0-140 km (effective distance) in increments of 1 km). Both metrics indicate how the landscape becomes increasingly more connected as threshold distances increase. Comparison of the two metrics shows how the level of connectivity is influenced by the addition of cost impedance.

For the straight-line analysis, at a < 10 km threshold distance, the landscape was largely composed of independent patches and small habitat clusters. Above 37 km, most of the habitat distribution was connected (Figure 2). The expected cluster size reveals major phase shifts in connectivity at 7.5-km for the straight-line distance and 15-km for the least-cost distance where the landscape shifts from being largely unconnected to being largely connected. Habitat patches are part of one cluster at 37-km threshold when using the straight-line distance. In contrast, habitat becomes connected at a 127-km threshold when movement-cost is used.

CONNECTIVITY GRAPHS

High quality caribou habitat is largely comprised of a group of clustered patches in the east-central part of the region, south and north of the Long Point component of the proposed national park. Figure 4 shows the connections that form at thresholds of 15-km and 72-km in the cost analysis (these distances were chosen to reflect the connection differences at these scales). The western, northern, and southern portions of the region consist of smaller, more isolated patches. Lakes account for 45% of the landscape and constrain animal movements to a north-south axis, between Lake Winnipeg and Lake Winnipegosis. Below the 15-km effective distance threshold, the landscape is generally fragmented and there are no linkages between the southern and northern part of the landscape. At the 15-km effective distance threshold, the north and the south is connected via stepping-stone patches, via an island hopping route across Cedar Lake. The northern and western regions are still disconnected from the main cluster. At the 72-km effective distance threshold, the western and northern regions are connected to the main cluster via several routes, while the main cluster has many more interconnections.

PATCH IMPORTANCE INDEX

At all distance thresholds, we computed the patch importance and area-weighted patch importance index for each high quality habitat patch. Figure 5 shows the maximum values obtained across thresholds from 0-126 km (the effective distance after which all patches form a single cluster). The patch importance index results highlight the large habitat patches involved in connecting one main habitat cluster, north of Cedar Lake. On the other hand, the results of the

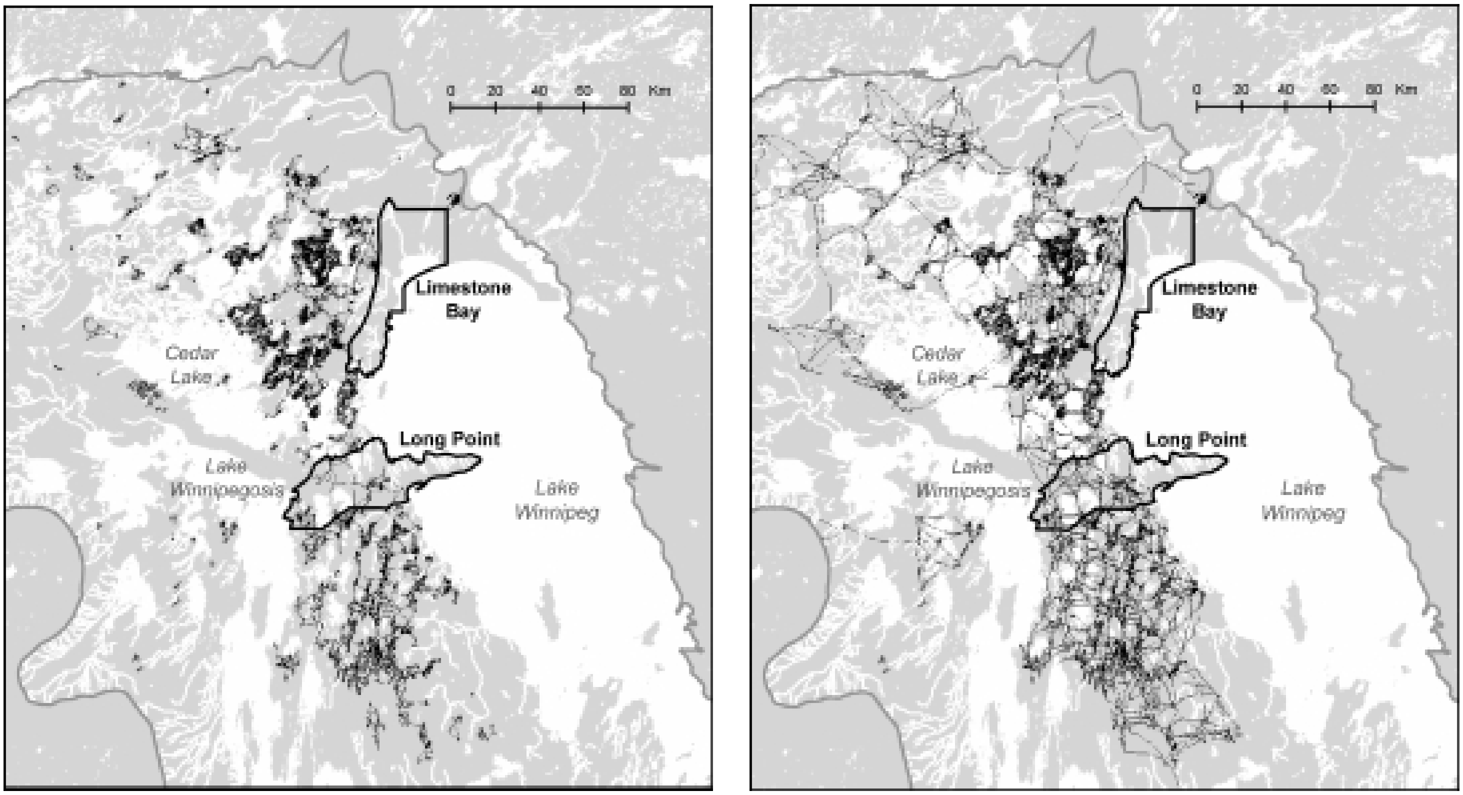


Figure 4. Connectivity edges for 15-km (left) and 72-km (right) effective distance thresholds based on the movement-cost surface. Dark areas represent caribou habitat at the landscape level. For example, the area south of Long Point is only connected with the northern areas at higher threshold distance.

area-weighted importance index highlight smaller habitat patches linking the southern and northern clusters and patches in the north-centre that contribute to maintaining connectivity with the more fragmented areas to the north-west. These smaller patches possibly act as stepping stones and may be important features of travel corridors.

DISCUSSION

High quality caribou habitat is largely comprised of a group of clustered patches in the east-central part of the Manitoba Natural Region. There are two large clusters of high quality habitat just south and north of the Long Point component of the proposed Manitoba Lowlands National Park and smaller clusters further west, near The Pas. Connectivity between high quality habitat patches is limited by the large lakes, constraining the animal movements to a north-south axis between Lake Winnipeg and Lake Winnipegosis. Furthermore, Cedar Lake (Manitoba Hydro reservoir) presents an additional barrier, weakening the north-south axis to an island hopping route (across Cedar Lake) or along highway 60 (the southern shore of Cedar Lake). This suggests that the Interlake woodland caribou herd, which is estimated at 54 animals and ranges over the cluster of patches south of Long Point (O'Brien et al. 2002), is probably isolated and that connectivity to the northern parts of the range is critical and should be maintained.

The incorporation of movement-cost information into the analysis was significant - it affected all connectivity metrics and changed the shape of the connected landscape. Work is ongoing to evaluate the sensitivity of the movement impedance parameters to the model output and extending the graph analysis methods. We will also be validating the model results using VHF and GPS datasets from other woodland caribou herds.

One of the major advantages of these new analyses resides in the ability to examine the landscape at different scales: patch (or forest stand), range (or part of a range), or multiple ranges. The connectivity analysis also allows different scenarios to be built (e.g., adding and removing high quality patches from the landscape, or adding and removing linear features) to assess the impact of different management options. In the case of the Interlake herd, the analyses proved useful for examining the region at a coarse scale, in an area where limited data on the species are available. The results clearly highlighted some of the challenges associated with species protection in the area, and should assist with the delineation of the park boundaries and further development of the woodland caribou conservation strategy.

ACKNOWLEDGEMENTS

This project was funded by Parks Canada's Species at Risk Recovery Funds and the Western Canada Service Centre. In-kind support was provided by Manitoba Conservation and Manitoba Hydro. Thank you to Jennifer Wood for the excellent GIS work.

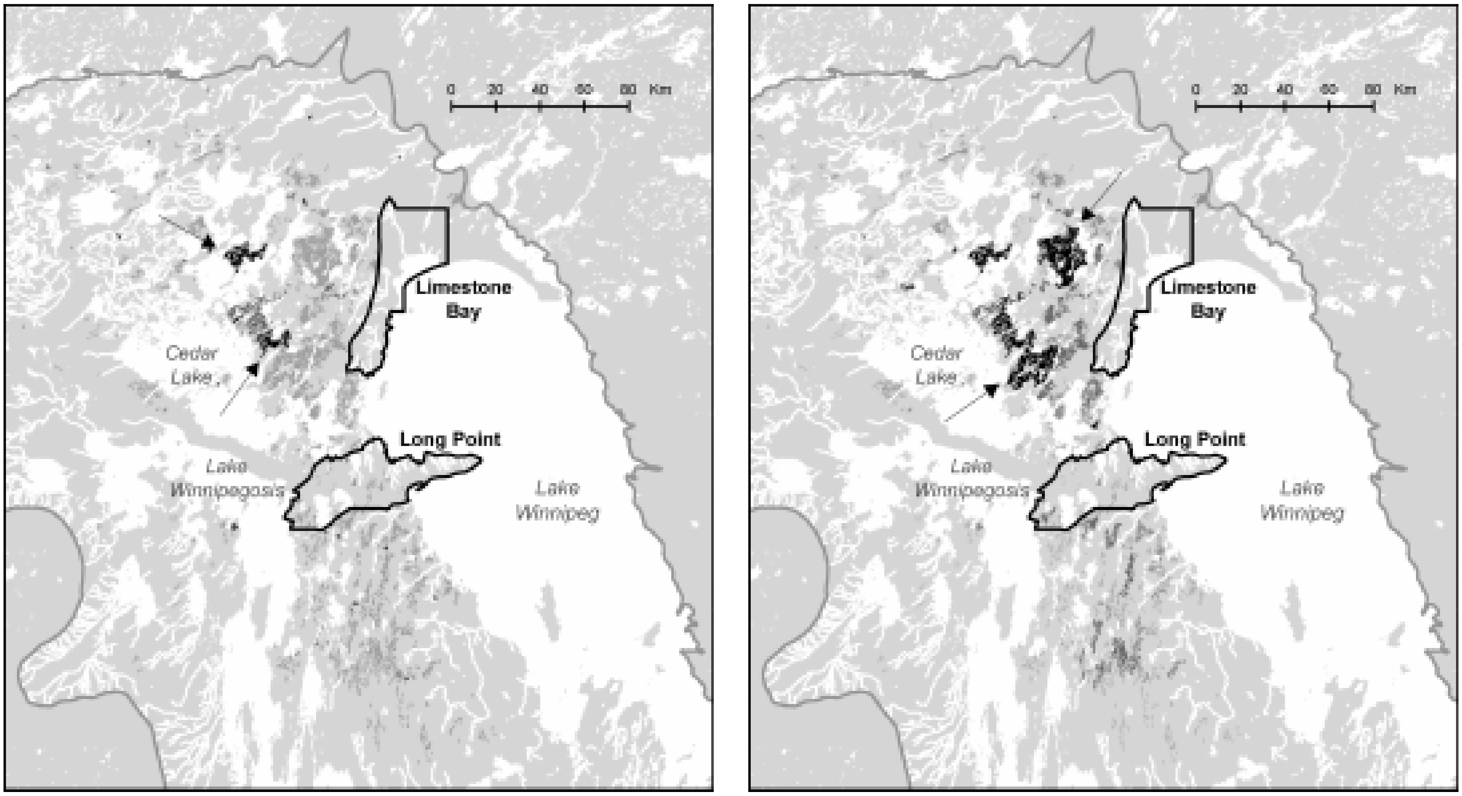


Figure 5. Comparison of two types of patch importance indices, calculated across all effective distance thresholds from 0 to 126 km. The left presents the maximum relative patch importance index, and the right presents the area-weighted importance index. Darker grays indicate higher values. Data are based on the movement-cost surface.

Dr. Micheline Manseau is a Boreal Ecologist with Parks Canada. Tel: (204) 983-8885; Micheline_Manseau@pc.gc.ca

Dr. Andrew Fall is the President of Gowlland Technologies Ltd. Tel: (250) 391-1918; fall@cs.sfu.ca

Dan O'Brien is a Research Assistant with the University of Toronto. Tel: (604) 733-2660; danobrien99@shaw.ca

Dr. Marie-Josée Fortin is a Landscape Ecologist with the University of Toronto. Tel: (416) 946-7886; mjfortin@zoo.utoronto.ca

APPENDIX 1

The *Expected Cluster Size (ECS)* is defined as:

$$ECS_d = \frac{\sum_{j=1}^{m} a_j^2}{a}$$

where there are *m* clusters in the CG at threshold *d*, and cluster *j* has area a_j and *a* is the total area of habitat.

The *Patch Importance Index* is defined as:

$$I_d^X(i) = \frac{X_d - X_d(i)}{X_d}$$

where X_d is the metric value at threshold distance d and $X_d(i)$ is the metric value for when removing patch *i*.

REFERENCES

Bunn, A.G., D.L. Urban, and T.H. Keitt. 2000. Landscape connectivity: A conservation application of graph theory. *Journal of Environmental Management* 59(4): 265-278.

Fall, A., and J. Fall. 2001. A domain-specific language for models of landscape dynamics. *Ecological Modelling* 141: 1-18.

Harary, F. 1969. *Graph theory*. Addison-Wesley series in mathematics. Addison-Wesley, Reading, Massachusetts, USA.

Keitt, T.H., D.L. Urban, and B.T. Milne. 1997. Detecting critical scales in fragmented landscapes. *Conservation Ecology* [Online] 1(1): 4. Available at URL: http://www.consecol.org/vol1/iss1/art4.

Manseau, M., F. Rennie, and C. Mondor. 2001. Determination of ecological boundaries for the establishment and management of Canadian National Parks. pp. 294-302 *In*: David Harmon (ed.). *Crossing Boundaries in Park Management: Proceedings of the 11th Conference on Research and Resource Management in Parks and on Public Lands*. The George Wright Society: Hancock, Michigan.

O'Brien, D. 2002. Influence of linear corridors on the distribution of woodland caribou in Southeastern Manitoba. Parks Canada. *Unpublished report*.

O'Brien, D., and M. Manseau. 2002. Assessing movement cost of Owl Lake Woodland Caribou in Habitat Patches of Variable Quality. Parks Canada. *Unpublished report*.

O'Brien, D., M. Manseau, K. Whaley, and D. Cross. 2002. Aerial survey of woodland caribou in the Manitoba Lowlands area. Parks Canada. *Unpublished report*.

Rebizant, K.J., R. Larche, G. Cameron, D. Cross, C. Elliot, P. Hildebrand, R. Robertson, D. Schindler, and K. Whaley. 2000. Woodland caribou (*Rangifer tarandus caribou*) conservation strategy for Manitoba. Wildlife Branch, Manitoba Conservation, Winnipeg, Manitoba.

B. READER

Garry Oak Ecosystems RECOVERY

The Garry Oak (*Quercus garryana*) ecosystems of southwest British Columbia are important for their great beauty and biological diversity. Today, less than 5 % of the original habitat remains due to factors like habitat loss, fragmentation, invasive exotic species, and altered fire regimes. Parks Canada is responsible for Garry Oak ecosystems in Fort Rodd Hill/Fisgard Lighthouse National Historic Sites and the proposed Gulf Islands National Park Reserve.

These ecosystems, described in British Columbia by the Conservation Data Centre (CDC) as imperiled, are home to 91 species 'at-risk' provincially and/or nationally. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) currently lists 22 species associated with Garry Oak ecosystems, with 13 of those classified *endangered*. COSEWIC is expected to list many more Garry Oak-associated species in the future.

To address regional recovery needs, Parks Canada is participating on the Garry Oak Ecosystems Recovery Team and has helped secure funding through sources like the Government of Canada Habitat Stewardship Program and Interdepartmental Recovery Fund. To date, over half a million dollars have been raised through the Habitat Stewardship Program alone. This is a relatively large and complex recovery effort consisting of approximately 80 agency representatives on the recovery team and recovery action groups.

Ongoing research and recovery work at Fort Rodd Hill/Fisgard Lighthouse National Historic Sites includes:

(1) Compiling baseline data on plant communities and diversity, and rare species occurrences;

(2) Controlling and removing invasive species, like Scotch broom (*Cytisus scoparius*) and Daphne (*Daphne laureola*);

(3) Rare plant surveys; and,

(4) Proposed invertebrate inventories.

In the future, rare plant surveys are planned for the unoccupied islets that will be included in the proposed Gulf Islands National Park Reserve. These islets hold great potential for discovery as they are rarely visited and poorly surveyed. Other similar islands and islets near Victoria have proven to be important refugia for several rare plant species.

B. READER

Daphne laureola, an invasive plant in Garry Oak ecosystems. TOP: Garry Oak Meadow, Tumbo Island. Tumbo Island has significant areas of Garry Oak ecosystems, and is included in the proposed Gulf Islands National Park Reserve.

Brian Reader, Species at Risk Ecologist, Parks Canada, brian_reader@pch.gc.ca

Piping Plover MONITORING at Kejimkujik National Park and National Historic Site

PARKS CANADA

Eastern Piping Plover

The eastern piping plover (*Charadrius melodus melodus*) is a small shorebird listed as an *endangered* species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) since 1985. In Atlantic Canada, piping plover nest above the high-water line on wide beaches, preferring open sand and beach cobble rock expanses with little or no vegetation.

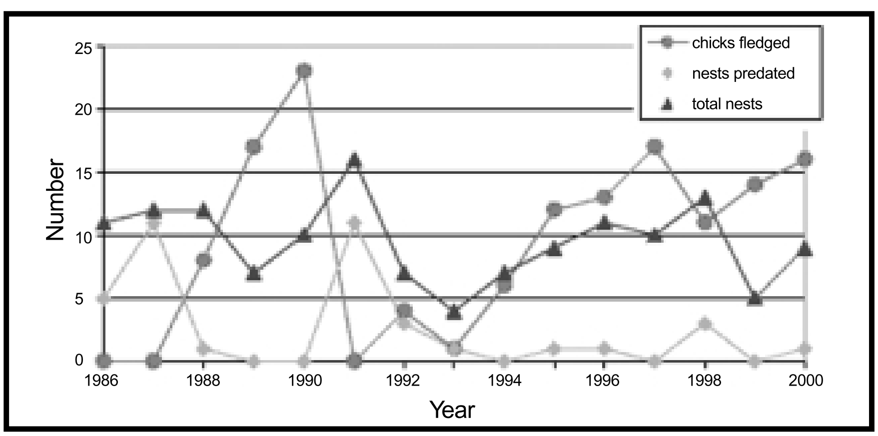
In the late 1970's, the number of piping plover in eastern Canada was estimated at 420 - 690 individuals, a population count believed to be below historic numbers (Boyne 2001). The 2001 International Census of Piping Plover counted 513 piping plover in eastern Canada (including Quebec). Surveys conducted since the 80's have shown that their population has remained relatively stable at 450 - 525 birds, below the goal of approximately 670 plover identified in the March 2002 National Piping Plover Recovery Plan.

The Seaside Adjunct is a 22.2 km^2 portion of Kejimkujik National Park and National Historic Site on Nova Scotia's south shore. The Adjunct contains beaches and sand dune systems with associated lagoon-saltwater marshland with many small lakes and ponds, soft & mixed wood forests and coastal heath land & rock barrens.

Parks Canada staff have been actively monitoring and managing piping plovers since the Adjunct's inception in 1986. Although previously found on other beaches within the park, the plover now only exist on St. Catherine's River Beach. From 1986 to 2001, between 4-10 pair of plover have nested in the Seaside Adjunct (varies from year to year). The fledgling success rate (fledged chicks/pair/year) has averaged 1.28 chicks, which is considered just high enough to sustain a viable population (i.e., > 1.25 fledged chicks/pair/year; Melvin and Gibbs 1996).

Ongoing management includes the closing of St. Catherine's River Beach plover nesting areas, installing nest exclosures around most nests (especially those considered at risk to predation), and ongoing monitoring of nest & egg clutches and chick survival & fledging. In addition, breeding habitat will be created by restoring sandy-rocky soil substrate in a 1 hectare area along the park's St. Catherine's River Beach near the salt water lagoon.

Richard Brunt, Park Warden, Parks Canada,
richard_brunt@pch.gc.ca



Piping plover fledging success, 1985 - 2000

Recently in PRINT

Brook, R. 2001. *Structure and dynamics of the vegetation in Wapusk National Park and the Cape Churchill Wildlife Management Area of Manitoba: Community and landscape scales*. Master's of Natural Resource Management thesis, Natural Resources Institute, University of Manitoba, Winnipeg, Manitoba. 305 pp.

Kay, C.E., and C.A. White. 2001. Reintroduction of bison into the Rocky Mountain parks of Canada: historical and archaeological evidence. pp. 143-151 *In*: Harmon, D. [Ed.]. *Crossing Boundaries in Park Management: Proceedings of the 11th Conference on Research and Resource Management in Parks and on Public Lands*. The George Wright Society, Hancock, Michigan.

LaMontagne, J.M., R.M.R. Barclay, and L.J. Jackson. 2001. Trumpeter swan behaviour at spring-migration stopover areas in southern Alberta. *Canadian Journal of Zoology* 79: 2036-2042.

M'Lot, M. 2002. KÂ ISINÂKWÂK ASKÎY: *Using Cree knowledge to perceive and describe the landscape of Wapusk National Park area*. Master's of Natural Resource Management thesis, Natural Resources Institute, University of Manitoba, Winnipeg, Manitoba. 109 p.

Manseau, M., F. Rennie, and C. Mondor. 2001. Determination of ecological boundaries for the establishment and management of Canadian National Parks. pp. 294-302 *In*: Harmon, D. [Ed.]. *Crossing Boundaries in Park Management: Proceedings of the 11th Conference on Research and Resource Management in Parks and on Public Lands*. The George Wright Society, Hancock, Michigan.

McMaster, N.L., and T. Herman. 2000. Occurrence, Habitat Selection, and Movement Patterns of Juvenile Blanding's Turtles (*Emydoidea blandingii*) in Kejimkujik National Park, Nova Scotia. Chelonian Conservation and Biology. *International Journal of Turtle and Tortoise Research* 3(4): 603-609.

O'Brien, D.T. 2001. *Measuring terrestrial net primary productivity in arctic ecosystems with AVHRR [Advanced Very High Resolution Radiometer] satellite imagery*. M.Sc. Thesis. Department of Botany, University of Manitoba, Winnipeg, Manitoba. 139 p.

Reynolds, C.K. 2002. *Upper Columbia River Region Black Bears (Ursus americanus) – A DNA mark-recapture study*. M.Sc. Thesis. University of Alberta, Department of Biological Sciences, Edmonton. 75 p.

Sloan, N.A., P.M. Bartier, and W.C. Autin. 2001. Living marine legacy of Gwaii Haanas. II: Marine invertebrate baseline to 2000 and invertebrate-related management issues. *Parks Canada – Technical Reports in Ecosystem Science 35*: 331 p.

Standing, L.K., T.B. Herman, M. Shallow, T. Power, and I. Morrison. 2000. Results of Nest Protection Programme for Blanding's Turtle in Kejimkujik National Park, Canada: 1987-1997. Chelonian Conservation and Biology. *International Journal of Turtle and Tortoise Research* 3(4): 637-642.

Suffling, R., and D. Scott. 2002. Assessment of climate change effects on Canada's national park system. *Environmental Monitoring and Assessment* 74: 117-139.

Weitzner, V., and M. Manseau. 2001. Taking the pulse of collaborative management in Canada's National Parks and National Park Reserves: Voices from the field. pp. 253-259 *In*: Harmon, D. [Ed.]. *Crossing Boundaries in Park Management: Proceedings of the 11th Conference on Research and Resource Management in Parks and on Public Lands*. The George Wright Society, Hancock, Michigan.

White, C.A., E.G. Langemann, C.C. Gates, C.E. Kay, T. Shury, and T.E. Hurd. 2001. Plains bison restoration in the Canadian Rocky Mountains? Ecological and management considerations. pp. 152-160 *In*: Harmon, D. [Ed.]. *Crossing Boundaries in Park Management: Proceedings of the 11th Conference on Research and Resource Management in Parks and on Public Lands*. The George Wright Society, Hancock, Michigan.

Research Links
SUMMER/FALL 2002
Volume 10, Number 2

CONTACT:

Research Links
Parks Canada
#550, 220-4 Ave. SE
Calgary, AB T2G 4X3
Phone: (403) 221-3210
Research_Links@pc.gc.ca

Research Links is published 3 times per year by Parks Canada.

ISSN 1496-6026 (in print)
ISSN 1497-0031(online)

Meetings of Interest

September 6-10, 2002 **Ecological and Earth Sciences in Mountain Areas,** The Banff Centre for Mountain Culture, Banff, AB. This is the 2nd conference in a 5-year series. It will focus on present and future conditions of ecological and earth sciences information for mountain habitats. Two major themes are ecological conditions of alpine animals, plants and their habitats, and biophysical concerns. Contact: leslie_taylor@banffcentre.ca, www.banffcentre.ca/cmc

October 1-6, 2002 **Lessons from the Islands: Introduced Species and What They Tell Us About How Ecosystems Work,** Queen Charlotte City, BC. The Research Group on Introduced Species (RGIS) has conducted 5 years of multidisciplinary research on the impacts of introduced species, particularly Sitka black-tailed deer, on the ecology of Haida Gwaii. This conference will focus on interactions between introduced species and changes in the ecology and biodiversity of harvested and protected forest systems. Contact: rgis@qcislands.net, Tel: (250) 559-2346, http://rgisbc.com.

October 16-18, 2002 **Mountain Caribou in the 21st Century**, Columbia Mountains Institute of Applied Ecology, Revelstoke, BC. This conference will focus on mountain caribou biology, population status, population stressors, management of forest operations, and habitat analysis & mapping. It will include 2 presentation days and 1 field-trip day. Contact: Tel: (250) 837-9311, www.cmiae.org.

October 19-20, 2002 **The Third Annual Bryoria Workshop**, Columbia Mountains Institute of Applied Ecology, Revelstoke, BC. This field course will introduce participants to the identification and field ecology of Bryoria and other arboreal forage lichens used by mountain caribou. Alternative management strategies for caribou habitat in ESSF ecosystems will be discussed. Register at www.cmiae.org. For more info contact the instructor, Trevor Goward, Tel: (250) 674-2553, tgoward@interchange.ubc.ca

November 5-8, 2002 **Meeting of Parks Canada's Geographic Information System (GIS) and Information Management (IM)/ Information Technology (IT) Communities**. Topics of mutual interest and concern such as knowledge management, convergence of technologies, and supporting science are being considered for discussion. For more information or to help organize: Greg MacMillan, Tel: (604) 666-3431, greg_macmillan@pch.gc.ca; Thomas Naughten, Tel: (204) 984-6227, thomas_naughten@pc.gc.ca

November 18-21, 2002 **DNA-Based Wildlife Studies – Study Design, Field Methods, Genetic Analysis, and Analysis of Mark-Recapture Data**, Columbia Mountains Institute of Applied Ecology, Revelstoke, BC. This course consists of three consecutive sessions: (1) Study Design and Field Methods for DNA-based Mark-Recapture Inventories; (2) Genetic Analysis of Individual Identity in DNA-based Inventories; and (3) Advanced Mark-Recapture Analysis of Genetic Data. Contact: Tel: (250) 837-9311, www.cmiae.org.