THE EFFECTS OF HABITAT PATCH SIZE ON AVIAN COMMUNITIES IN ASPEN PARKLANDS

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The following text is a summary from Johns (in press).

INTRODUCTION

The aspen parklands is a transition zone between boreal forest and grassland. Diversity of avian species and abundance of individuals in Aspen (*Populus tremuloides*) are generally higher than in most other habitats, except perhaps mixedwood forest. This diversity may be partly related to the ecotonal nature of the parklands.

The productivity of parkland soils for agriculture has encouraged intensive cultivation which has significantly altered the parklands, grasslands have been cultivated, aspen groves cleared, and wetlands filled or drained.

The objective of this study, was to determine the relationship between aspen grove size and bird species richness in agricultural land within the aspen parklands of central Saskatchewan.

STUDY AREA

The study was conducted near Saskatoon, Saskatchewan. Twenty-seven aspen groves, 0.04 ha to 36.7 ha in size, were randomly chosen.

METHODS

I used a modified point count to census birds. Three 20 minute visits were made to every point, in each of the three breeding seasons (May 26 to July 4 of 1984, 1985, and 1986). I measured isolation of each grove from its nearest neighbour and from the nearest large grove.

RESULTS

Area and Isolation

In my study area, small groves (less than 2 ha) were highly isolated from other groves, especially from larger groves (those greater than 2 ha). The large groves were in close proximity to other large groves.

Species Richness and Abundance

Fifty species of birds were recorded from the 27 aspen groves studied during the breeding seasons of 1984 (39 species), 1985 (42 species), and 1986 (46 species). Forty-one of those species had territories that were small enough to be restricted to the groves that they were recorded in. These species were used in the calculations of species richness.

The number of species, at each census point, increased with an increase in area of aspen grove. The number of individuals at each census point also increased with an increase in area of the grove.

Habitat Guilds

The number of edge (those species preferring the edges of aspen groves), interior/edge (those species occurring throughout the grove), and interior species (those species that occur only within the heart of larger groves) each increased with an increase in the size of the grove.

Foraging Guilds

There was no noticeable increase in omnivore species richness over the size range of groves studied, however, the number of insectivorous species increased dramatically with an increase in grove area.

Migratory Status

The number of species of long- and short-distance migrants and permanent residents each increased with an increase in the size of the grove.

Responses of Individual Species

Individual species' responses were calculated for 31 species of birds (Table 1). Fifteen of those showed a significant increase with an increase in grove area; one species, the Clay-coloured Sparrow (*Spizella pallida*), showed a significant increase with increased isolation while three other species demonstrated a significant negative trend with increased isolation; and one species (Least Flycatcher [*Empidonax minimus*]) was related to both area (+) and isolation (-).

SUMMARY

1. Aspen grove size influences the composition of the bird community. The abundance and diversity of avifauna were significantly correlated with grove size.

2. Species richness of edge, interior/edge, and interior species were each significantly correlated with area.

3. Species richness of insectivores was strongly correlated with area, whereas for omnivores it was not.

4. Migratory strategy was correlated with size of grove.

5. The densities of 15 species were correlated with area, densities of four species were correlated with isolation, and the density of one species was correlated with both.

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Table 1. Species relationships with area and isolation in Saskatchewan parklands, 1984 to 1986

Species that increased with increasing area	Species that increased (+) or decreased (-) with increasing isolation	Species that increased (+) or decreased (-) with increasing area and isolation
Mourning Dove (*Zenaida macroura*)	Veery (-) (*Catharus fuscescens*)	Least Flycatcher (*Empidonax minimus*) (+ area, - isolation)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	Ovenbird (-) (*Seiurus aurocapillus*)	
Downy Woodpecker (*Picoides pubescens*)	Connecticut Warbler (-) (*Oporornis agilis*)	
Hairy Woodpecker (*P. villosus*)	Clay-colored Sparrow (+) (*Spizella pallida*)	
Great-crested Flycatcher (*Myiarchus crinitus*)		
Black-capped Chickadee (*Parus atricapillus*)		
House Wren (*Troglodytes aedon*)		
Cedar Waxwing (*Bombycilla cedrorum*)		
Warbling Vireo (*Vireo gilvus*)		
Red-eyed Vireo (*V. olivaceus*)		
American Redstart (*Setophaga ruticilla*)		
Rufous-sided Towhee (*Pipilo erythrophthalmus*)		
Vesper Sparrow (*Pooecetes gramineus*)		
Brown-headed Cowbird (*Molothrus ater*)		
Northern Oriole (*Icterus galbula*)		

HABITAT FRAGMENTATION AND BURROWING OWLS IN SASKATCHEWAN

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INTRODUCTION

The role of habitat fragmentation in the decline of North American forest birds has been recognized over the last 15 years (Terborgh 1989). However, the role that such fragmentation plays in the conservation of prairie birds is still quite unknown despite the fact that the Canadian prairie ecosystem is one of the most heavily fragmented in the world. With this in mind, I conducted a preliminary investigation into whether habitat area has any effect on Burrowing Owl (*Athene cunicularia*) numbers, occupancy, reproduction, mortality, and movements. The Burrowing Owl is designated as threatened in Canada and habitat loss has been identified as one of the primary factors influencing the decline of the species. Despite this, little is known about the effect of habitat fragmentation on Burrowing Owls.

METHODS

The data for this study were derived from two sources. Firstly, pasture size and occupancy by owls across southern Saskatchewan were obtained from Operation Burrowing Owl data files of the Saskatchewan Natural History Society (Palmer and Hjertaas 1991). Data for reproduction, mortality, and movements in relation to habitat area were obtained from an ongoing study of Burrowing Owls on the Regina Plain (James and Fox 1987, James et al. 1990, James et al. 1991).

RESULTS

Across southern Saskatchewan, a significant association ($r = 0.17$, $n = 136$, $p = 0.05$) was detected between the number of breeding pairs of owls over a 5-year period and the size of the pasture (Figure 1). However, it should be noted that while absolute numbers of owls increased on larger pastures, they existed at much lower densities due to the logarithmic nature

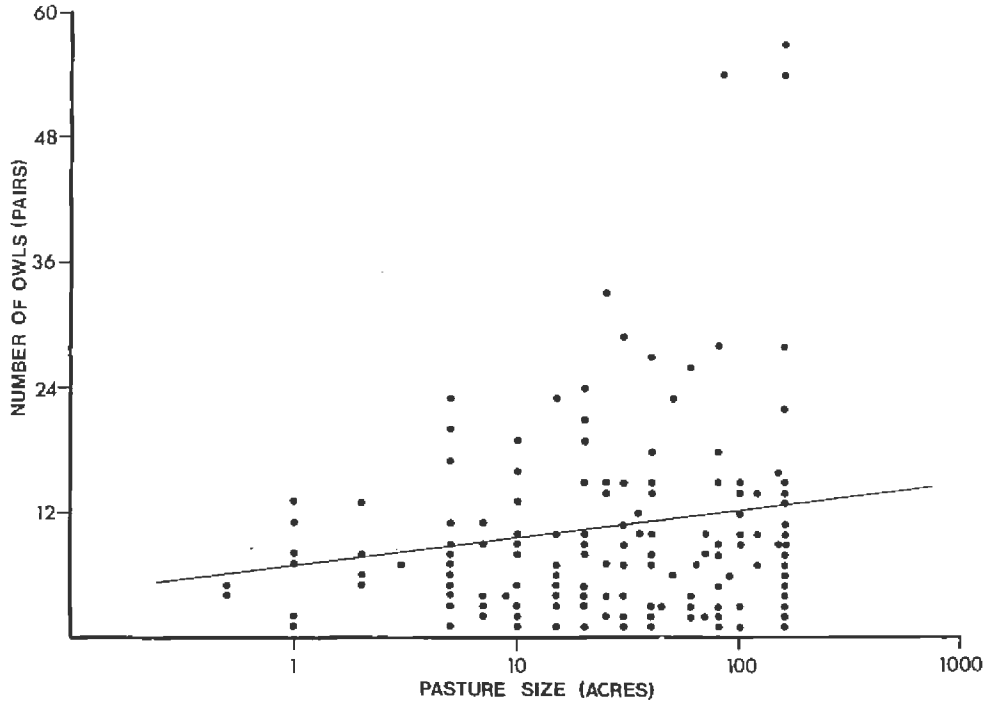

Figure 1. Number of Burrowing Owl pairs nesting over a 5-year period on pastures of different sizes. Operation Burrowing Owl data.

of the pasture size data. In addition, pastures that had been occupied for all five years were significantly (t test, $p = 0.01$) larger (mean 76.1 acres, median 65 acres, $n = 54$) than pastures that were occupied from one to four years (mean 47.5 acres, median 30 acres, $n = 160$).

On the Regina Plain study area, no significant relationships could be detected between pasture size and the proportion of nests that failed ($r = 0.41$, $n = 15$), the number of chicks produced by successful pairs ($r = -0.23$, $n = 16$), the survivorship of adults ($r = 0.14$, $n = 11$), or the survivorship of juveniles ($r = 0.42$, $n = 9$). However, the sample size of pastures examined was much smaller than that of Operation Burrowing Owl. Finally, there was no significant net movement of owls between different sized pastures between years. Ten adults or juveniles moved from smaller to larger pastures, and seven adults or juveniles moved from larger to smaller pastures.

DISCUSSION

Clearly, pasture size does have an effect on the number of Burrowing Owls present as well as on their length of occupancy (Figure 1). Larger pastures contain more breeding pairs and they persist longer. However, the relationship is a very weak one owing to a large number of larger pastures not having increased numbers of owls. In addition, the number of owls does not increase in direct proportion to increase in pasture size. In fact, to get a doubling in number of owls requires, on average, 100 times the amount of pasture assuming that the relationship is a linear one, which it may not be (Figure 1). No pastures over 160 acres were included in this analysis, probably owing to their relative scarcity. It would therefore, be interesting to know more about Burrowing Owls on larger pastures in order to fully understand the true nature of the area/number relationship.

Given that larger pastures have more owls, it is perhaps not surprising that pastures that were occupied longer were larger. A smaller number of owls on a pasture is maybe likely to become extinct purely as a matter of chance. However, smaller pastures may also be subject to heavier levels of predation (Terborgh 1989) leading to the same result. Further work is needed on this point despite the preliminary results from the Regina Plain showing no such effects.

In summary, it would appear that pasture area may be playing an important role in the population ecology of the Burrowing Owl in Saskatchewan. However, more detailed analyses are required to further elucidate this and other relationships. In particular, it would be useful to also examine the effects of pasture edge, adjacent habitat land uses, isolation, and time since fragmentation and to conduct more work on owls on larger fragments of habitat. Given the role that predators seem to be playing in other studies of habitat fragmentation, it would also be useful to examine them more closely than what we have to date.

ACKNOWLEDGMENTS

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TOWARDS A CANADIAN CONSERVATION STRATEGY FOR RAPTORS

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The conservation of wildlife is important to most Canadians. Increasingly, Canadians are aware of the plight of many species of wildlife. In 1981, 80% of Canadians felt it was important to conserve abundant wildlife (Filion et al. 1985). This number rose to 83% by 1987 (Filion et al. 1989). These percentages are only slightly lower than those for Canadians who felt it was important to conserve endangered species (82% and 85% respectively, ibid.).

Reflecting these figures, the federal Green Plan incorporates wildlife in its conservation strategy (Government of Canada 1990). Songbirds in particular are singled out for attention. Past conservation activities of federal, provincial, and territorial wildlife agencies emphasized game and endangered species. Thus it is appropriate, if not overdue, that songbirds are afforded increased attention. However, in my view, adequate attention has not been given to another group of species—raptors. This paper expresses concerns about the current status of raptor conservation and proposes possible solutions to these concerns.

BACKGROUND

The Migratory Bird Convention Act (1917) excludes raptors. Raptor management and conservation is a provincial and territorial responsibility. The activities of the provinces and territories on raptors have focused almost exclusively within their borders.

Eleven species and subspecies of raptors are listed by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) as of April 1992. Two are endangered - Peregrine Falcon (*Falco peregrinus anatum*) and Spotted Owl (*Strix occidentalis*); two are threatened - Ferruginous Hawk (*Buteo regalis*) and Burrowing Owl (*Athene cunicularia*); and seven are vulnerable - Cooper's Hawk (*Accipiter cooperii*); Red-shouldered Hawk (*Buteo lineatus*); Peregrine Falcons (*F. p. tundrius* and *F. p. pealei*); Common Barn Owl (*Tyto alba*); Flammulated Owl (*Otus flammeolus*); and Great Gray Owl (*Strix nebulosa*). Three raptor species have formal recovery plans although as of February 1992 only one, the *Anatum* Peregrine Falcon recovery plan, has been approved by the wildlife directors (the other two, Burrowing Owl and Ferruginous Hawk, were approved in November 1992). The RENEW (Recovery of Nationally Endangered Wildlife) Committee's policy does not mandate recovery teams for vulnerable species. However, their goal is "to prevent other species from becoming at risk" (page i, RENEW 1988) or "no species be allowed to become threatened" (page 1, ibid).

Five of 16 species of owls and six of 19 species of diurnal raptors that breed in Canada are listed as endangered, threatened, or vulnerable (Table 1). Thus 26% of the species of raptors are listed by COSEWIC, a higher percentage than any other species group. Most of these raptors in jeopardy migrate south of Canada in winter (Table 2). Some species winter in

Table 1. Summary of the number of species of Canadian raptors that occur in United States and Latin America (Godfrey 1986) and are listed by COSEWIC as of 1992.

	Breed in Canada	Winter in Canada	Winter in U.S.A.	Winter in Lat. Am.	Winter in Mexico	COSEWIC[1]
Diurnal Raptors	19	11	17	18	6	E = 1 T = 1 V = 4
Owls	16	15	16	1	1	E = 1 T = 1 V = 3

[1]E = Endangered, T = Threatened, V = Vulnerable

Table 2. Status and distribution of raptors that occur in Canada.

Species	Status[1]	Breeding range in Canada[2]	Winter range of Canadian Owls[3]	1992 COSEWIC status[4]
Common Barn Owl (*Tyto alba*)	B	R-S	C, U	V
Flammulated Owl (*Otus flammeolus*)	B	R-S	C, U	V
Eastern Screech-owl (*O. asio*)	B	R-S	C, U	
Western Screech-owl (*O. kennicottii*)	B	R-S	C, U	
Great Horned Owl (*Bubo virginianus*)	B	W	C, U	
Snowy Owl (*Nyctea scandiaca*)	B	A	C, U	
Northern Hawk-Owl (*Surnia ulula*)	B	W	C, U	
Northern Pygmy-owl (*Glaucidium gnoma*)	B	R-S	C, U	
Burrowing Owl (*Athene cunicularia*)	B	R-S	U, M	T
Spotted Owl (*Strix occidentalis*)	B	R-S	C, U	E
Barred Owl (*S. varia*)	B	W	C, U	
Great Gray Owl (*S. nebulosa*)	B	W	C, U	V
Long-eared Owl (*Asio otus*)	B	W	C, U	
Short-eared Owl (*A. flammeus*)	B	W	C, U	
Boreal Owl (*Aegolius funereus*)	B	W	C, U	
Northern Saw-whet Owl (*A. acadicus*)	B	W	C, U	
Black Vulture (*Coragyps atratus*)	A	N	U, L	
Turkey Vulture (*Cathartes aura*)	B	R-S	U, L	
Osprey (*Pandion haliaetus*)	B	W	U, L	
American Swallow-tailed Kite (*Elanoides forficatus*)	A	N	U, L	
Mississippi Kite (*Ictinia mississippiensis*)	A	N	U, L	
Bald Eagle (*Haliaeetus leucocephalus*)	B	W	C, U, M	
Northern Harrier (*Circus cyaneus*)	B	W	C, U, L	
Sharp-shinned Hawk (*Accipiter striatus*)	B	W	C, U, L	
Cooper's Hawk (*A. cooperii*)	B	R-S	U, L	V
Northern Goshawk (*A. gentilis*)	B	W	C, U, M	
Red-shouldered Hawk (*Buteo lineatus*)	B	R-S	U, M	V
Broad-winged Hawk (*B. platypterus*)	B	B-S	L	
Swainson's Hawk (*B. swainsoni*)	B	R	L	

Red-tailed Hawk (*B. jamaicensis*)	B	W	U, L	
Ferruginous Hawk (*B. regalis*)	B	R-S	U, M	T
Rough-legged Hawk (*B. lagopus*)	B	A	C, U	
Golden Eagle (*Aquila chrysaetos*)	B	W	C, U, M	
Eurasian Kestrel (*Falco tinnunculus*)	A	N	-	
Americau Kestrel (*F. sparverius*)	B	W	C, U, L	
Merlin (*F. columbarius*)	B	W	C, U, L	
Peregrine Falcon (*F. peregrinus*)	B	W	C, U, L	E, V, V[5]
Gyrfalcon (*F. rusticolus*)	B	A	C, U	
Prairie Falcon (*F. mexicanus*)	B	R-S	C, U, M	

[1]Status: A = Accidental - not recorded annually in Canada; B = Breeds.

[2]Breeding Range: R = Restricted (S = southern, N = northern); B = Boreal forest; W = Widely distributed; A = Arctic; N = Non-breeder.

[3]Winter Range: C = in Canada; U = in United States; L = in Latin America; M = in Mexico.

[4]COSEWIC Status: E = Endangered; T = Threatened; V = Vulnerable; blank = not listed by COSEWIC.

[5]Refers to subspecies *anatum*, *tundrius*, and *pealei* respectively

Canada and the United States while others migrate as far south as Argentina and Chile. Many winter in tropical Central America. Little is known about tbeir winter habitats or ecology. For some species such as the Burrowing Owl we do not know where the Canadian breeding population spends the winter (James and Ethier 1989). Eighteen of the 19 diurnal raptors and one of the owls are neotropical migrants. All 35 species winter in or migrate through the United States.

An international agreement, CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) lists all species of Canadian raptors. This convention restricts the movement of wildlife and wildlife parts between signatory countries, including Canada (see Dauphine 1987 for details). The convention does not address any other species' conservation concerns. CITES restricts the export of raptors and raptor parts from Canada.

Several relevant raptor management documents have been prepared in the United States. Olendorff et al. (1980) reviewed raptor management in the 1970s in the United States and categorized activities into captive breeding projects, egg manipulations for raptor management, introduction techniques for raptors, establishment of key raptor habitat reserves, and a proliferation of raptor habitat management projects. Olendorff et al. (1989) described objectives, goals, and actions to manage raptor habitat on lands of the United States Bureau of Land Management (BLM) in the western states and Alaska. For BLM lands, this report details the status of raptor habitat, effect of land use activities, and key raptor areas.

RAPTOR CONSERVATION ISSUES

Many conservation issues surround Canadian raptors. This section briefly outlines these issues in a preliminary fashion. A more complete review is part of the proposal presented in this paper.

Monitoring

The distribution, population size, and trends of most raptors are poorly or not known, especially in Canada. Bird monitoring techniques sucb as breeding bird surveys (Robbins et al. 1986, Buchanan 1988), and Christmas Bird Counts (Root 1988) monitor some diurnal raptors and few nocturnal owls. However, sample sizes are small for most species (e.g., 1 Cooper's Hawk and 1 Great Horned Owl [*Bubo virginianus*] per 33 Breeding Bird Survey routes) and few surveys are conducted in boreal and northern Canada. Raptor migration is monitored at many sites across the United States but at few sites in Canada. At these sites some

useful long-term trends have been established, but many species are not covered.

Habitat

The general breeding habitat preferences of many raptors are known. Likewise we know the range of most species. However, we know relatively little about the specific habitat needs such as abundance of prey, breeding site, and foraging habitat. Productivity varies between habitat for all species. In some habitats, breeding birds produce a surplus of young (source habitat) while in other habitats the adults do not produce enough young to replace themselves (sink habitat) (Newton 1992). Source and sink habitats need to be defined for all raptors.

Environmental Assessment

The impact of land management practices on raptors is unknown in Canada. Environmental assessments use habitat-species relationships to predict the consequences of development on wildlife. Schmutz (1987) showed that intermediate agricultural activity increases the density of Swainson's Hawks (*Buteo swainsoni*) over native habitat and complete agriculture. Such examples are rare and more research needs to be done on the interaction between each development and the affected raptors.

Habitat Outside Canada

Seventeen species of raptors that occur in Canada are considered "neotropical migrants" by the United States Partners in Flight Program. These species breed in Canada and migrate to Central and South America for our winter. The migration and wintering habitats of many raptors are unknown or only poorly known. These habitats need to be identified and adequately protected in reserves, and managed for raptor survival. Likewise, little is known about mortality factors and toxicology issues in winter. Most, if not all Latin American countries have limited resources to study these migrant species.

Toxicology

Since raptors are at or near the top of the food chain, they accumulate persistent chemicals as well as being vulnerable to direct and secondary poisoning. The most famous example of bioaccumulation of a detrimental pesticide is the levels of DDT/DDE in Peregrine Falcons which caused thin egg shells and reproductive failure (Hickey 1969). The bioaccumulation of heavy metals and pesticides in raptors varies with their diet, geographic range, and habitat preferences. Direct poisoning occurs when the raptors are sprayed with a pesticide or ingest a toxic chemical. Carbofuran spraying of Burrowing Owls is an example (James and Fox 1987). Secondary poisoning occurs when raptors eat prey that are poisoned themselves. Fenthion, used to kill pigeons, has subsequently killed raptors (Lacombe et al., in press).

Mortality

Raptors are killed by many human activities such as: shooting; introduced disease, vehicle collisions, breeding disturbance; electrocution, and collisions with windows, buildings, and wires. The impact of these mortality factors needs to be assessed and where necessary, mitigated.

Falconry

Falconry is legal and is practiced in British Columbia, Alberta, Saskatchewan, Ontario, and Yukon. The impact of falconry is controversial especially in Ontario, but its documented impact on raptor populations or their prey appears minimal.

Education

Raptors hold a special fascination with the public. The public is interested in the raptors' shape and hunting skills. Because of this interest, raptors are particularly well suited as a focus for public education about wildlife conservation and broader environmental issues.

Raptors also occupy the top of some food chains. Landowners see many raptors soaring over their land or nesting on it. Consequently, raptors can be used as indicators of the quality of land management practices and as ambassadors of conservation of native habitat.

Research

Research on raptors is conducted primarily by a few university researchers in Canada. Recent federal-provincial forestry agreements initiated model forest research projects and some monitoring and research on raptors can be expected in most of these projects. Some government wildlife agencies monitor some raptor population but have few resources for research.

Research could help to provide answers to conservation problems. The conservation issues that would benefit from more research activity include: evaluation of survey techniques to monitor populations, determination of habitat use and diet, studies of the impacts of agricultural and forestry activities on raptors, and the risks posed by toxic chemicals. All of these issues need studying in Canada and Latin America.

Partnerships

Raptors and associated human activities are managed by provincial and territorial wildlife agencies. Management efforts would be more effective and efficient with improved communication among themselves or with researchers on issues such as raptor banding, falconry, raptor rehabilitation, and toxicology.

Likewise, there is little international communication and cooperation about raptors, even though breeding populations are contiguous with the United States and many migrate to Latin America. An international migratory bird agreement that included raptors in the western hemisphere would promote conservation and education.

Rehabilitation

Raptor rehabilitation is practised in most or all provinces and territories in Canada and is controlled by permits for the appropriate provincial and territorial jurisdiction. The effectiveness of these facilities needs evaluation nationally. Also communication between facilities needs to be increased to share information. National leadership to form a Canadian association would expedite the continued role and effectiveness of these facilities.

CONCLUSION

Since a high proportion of raptors appear to be at risk in Canada and many are neotropical migrants, there is a need for a concerted effort to manage these species both in Canada and in the rest of the Western Hemisphere. The many issues that surround raptors could be efficiently addressed by a national conservation strategy. Such a strategy could propose national and international ways to promote raptor conservation while reinforcing those issues that should remain with the current jurisdictions.

The strategy should be developed by a task force comprised of federal, provincial, territorial, university, industry, and non-profit agency representatives. They should be mandated by and report to a national body such as RENEW or the Federal-Provincial Wildlife Conference. The conservation strategy should identify solutions that are practiced under existing legal and administrative arrangements as well as proposing new tools to conserve these species.

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"WILD HUNTERS - PREDATORS IN PERIL" - A CONSERVATION STRATEGY FOR LARGE CARNIVORES IN CANADA

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INTRODUCTION

The presentation you will see today is what we provide to popular audiences across Canada. Based on World Wildlife Fund's (WWF) Conservation Strategy for Large Carnivores in Canada (Hummel 1990), and "Wild Hunters - Predators in Peril", a new WWF book (Hummel and Pettigrew 1991). Illustrated by Robert Bateman, we've detailed the historical and current situation facing Canada's six top predators, namely the Polar Bear (*Ursus maritimus*), Grizzly Bear (*Ursus arctos*), Black Bear (*Ursus americanus*), Wolf (*Canis lupus*), Cougar (*Felis concolor*), and the Wolverine (*Gulo gulo*). "Wild Hunters" doesn't stop at outlining the biology and threats to these top predators, but also details a "Blueprint for Survival" for each species.

It's ironic that these powerful carnivores at the top of the food chain have fared the worst in relation to humans. Addressing the often asked question, "why conserve these animals in the first place?," we show how each of these top predators plays an important role in natural systems. They regulate prey numbers that have evolved to exist in higher numbers. They are often "indicators" of ecosystem integrity because they require large areas of remote wilderness in which to live. If an area is big enough to include top predators, it likely accommodates the many other species in that ecosystem; and, top predators are an integral part of maintaining biological diversity. By conserving top predators, and the habitats of which they are a part, we'd be conserving biological diversity.

Another reason for conserving top predators is their value to people. Top predators played, and still play, important roles in aboriginal native cultures and economies. These animals are used by hunting communities of present day society. More recently, wildlife viewing is proving very important to local communities, as well. For example, Churchill, Manitoba is now billed as "the Polar Bear capital of the world," hosting tourists who come from far and wide to view these magnificent arctic bears.

Despite the dollar value of top predators, many people feel these species are worth saving for their own sake. Surely it's important to hang onto the different forms of life, whether or not they are useful to us.

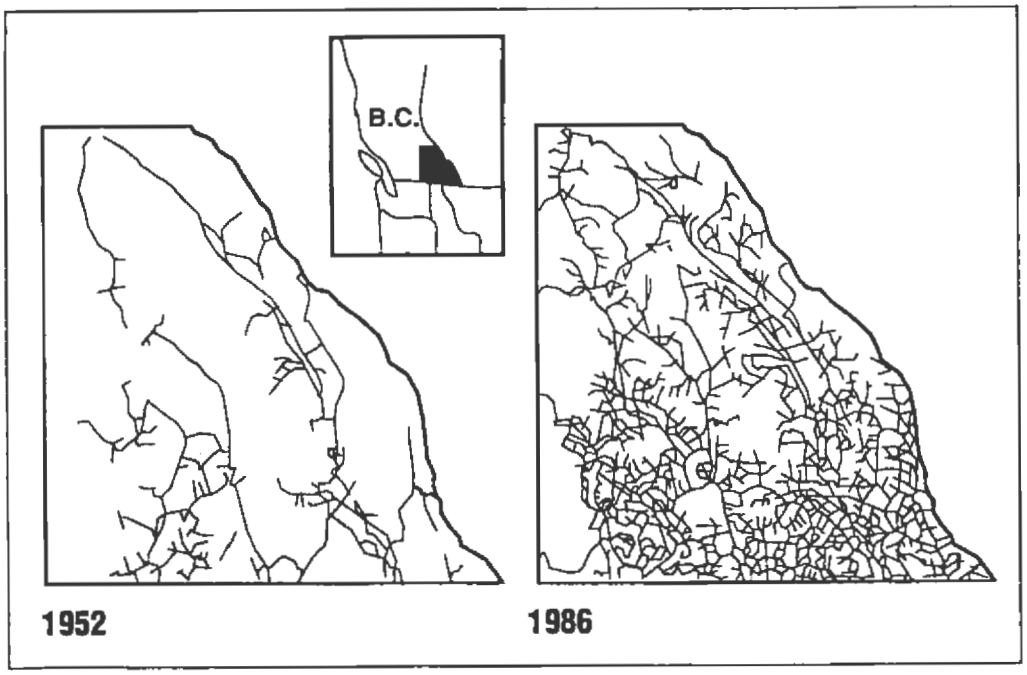
Finally, it's important to conserve top predators in Canada because there's a real urgency to the situation: they're taking their last stand, globally, in this country! Figure 1 clearly shows one of the reasons why: it compares the increase in access roads over the last 30 years in only one area of British Columbia. Increased access into wilderness backcountry is one of the greatest threats to all wildlife, causing disturbance of habitat, displacement of wildlife, and making hunting or poaching that much easier.

Top predators are now found right across the spectrum with respect to the classification of species in Canada. As seen in Figure 2, some of these top predators, or subpopulations of them, range from abundant, to rare or vulnerable, to threatened or endangered, through to those on the brink of extinction, such as the Eastern Cougar (*Felis concolor couguar*).

THE POLAR BEAR

The Polar Bear, an arctic marine mammal, is a very slow reproducing top predator. Polar Bears become sexually mature only after reaching four to six years of age, and usually give birth to one or two cubs which stay with the female for approximately 2½ years. This means that, on average, the female will only breed every third year and since cub survival rate varies, some female Polar Bears may not even "replace themselves" in the course of their lifetime. Female Polar Bears den from mid-October to mid-November, often returning to den sites where they themselves were born.

Ringed Seals (*Phoca hispida*) are the primary food of Polar Bears, although Bearded (*Erignathus barbatus*), Harp (*Phoca groenlandica*), and Hooded Seals (*Cystophora cristata*), Walruses (*Odobenus rosmarus*), Belugas (*Delphinapterus leucas*), and Narwhals



Source: B.C. Wildlife Branch, Cranbrook Regional Office.

Figure 1. Road development in the Kootenays.

Abundant	Vulnerable	Threatened	Endangered
Black Bear	Polar Bear		Eastern Wolverine
Wolf	Western Wolverine		
Western Cougar	Grizzly Bear		Eastern Cougar

Figure 2. Predator status scale.

(*Monodon monoceros*) can also make up a portion of their diets. The abundance and distribution of Polar Bears in Canada is directly related to the abundance and distribution of seals. However, contamination from oil, PCBs, and toxic metals are increasing threats to Polar Bears and their prey in the Arctic.

When Polar Bears come into contact with people, they often become what are called "problem" bears. Although many garbage dumps have been cleaned up, it is what people do that makes problems out of wildlife.

There are more than 15 subpopulations of Polar Bears worldwide, 12 of which are in Canada. Scientists estimate the worldwide population to be between 25,000 to 40,000 animals. Canada is home to half of these.

Blueprint for Survival

International Cooperation

To ensure the future of Polar Bears, Canada must continue its participation in the International Agreement on the Conservation of Polar Bears and Their Habitat (appended in "Wild Hunters") and its role in the World Conservation Union (formerly International Union for the Conservation of Nature, [IUCN]) Polar Bear Specialist Group.

Canadian Measures

Canada must also continue coordinating both research and management measures, particularly as some bear subpopulations are "shared" by different jurisdictions and are, therefore, under differing pressures.

Aboriginal Hunting

Inuit residents still hunt the Polar Bear, which commands a high place in their culture and economy. It is very important that hunting quotas are worked out in cooperation with aboriginal peoples; about 700 Polar Bears are killed every year.

Protecting Critical Habitats

The protection of critical habitats, such as den sites and key feeding areas, must be ensured.

Reducing and Preventing Industrial Impacts and Toxic Chemicals and Greenhouse Gasses

It's crucial to reduce and prevent the industrial effects of development in the Arctic, oil pollution, tanker traffic, as well as toxic chemicals and greenhouse gases. What we do elsewhere can and does impact Polar Bears in the north.

Research Needs for Conservation

There are at least five areas of research that need to be further developed and funded. These include obtaining better data on the size and boundaries of subpopulations, through to better understanding Polar Bear reproduction.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Designation

Worldwide, the Polar Bear has been classified by the IUCN (now the World Conservation Union) as "Vulnerable," and is listed on Appendix II of Convention on International Trade in Endangered Species (CITES). In April 1991, Canada's Polar Bears were classified by the COSEWIC as "Vulnerable," not because Polar Bears are an endangered species, but because they are naturally found in low numbers over large areas, they have a slow reproductive rate, and they are vulnerable to negative environmental affects.

THE GRIZZLY BEAR

The Grizzly Bear, a member of the brown bear family, was once the most widespread bear species in the world.

The grizzly is the slowest reproducing top predator in Canada, females becoming sexually mature only after reaching five to eight years of age. They may then only reproduce at three to eight year intervals, having just one or two cubs.

Grizzlies require immense home ranges. Alpine habitat is very important to them, a habitat type that is under increasing pressure in some areas of Canada for agriculture, which results in displacing grizzlies. Resource extraction and development in wilderness can destroy habitat, and provide increased human access into backcountry.

Another direct pressure on Grizzly Bears is hunting, both legal and illegal. In most areas of Canada, it is still legal to hunt grizzlies in both the fall and the spring. Some studies have shown that in the 12 zones where Grizzly Bears still exist in Canada, they are legally over-hunted in five. This doesn't include illegal hunting for which the head and paws are removed for trophies and jewellery.

As with Polar Bears, grizzlies are often attracted to human habitation where garbage is carelessly managed. Often, a problem bear becomes a dead bear. Although a grizzly takes the blame for frightening or attacking a human, it is usually our own lack of knowledge about bear behaviour that results in such tragedy.

Blueprint for Survival

Conservation Status in the United States and Canada

The Grizzly Bear has been eliminated from 99% of its range in the lower 48 United States, leaving only 700 to 900 bears more or less confined to six national parks there. Even here, in Canada, grizzlies occupy just over half their historic range, with population estimates of about 25,000 Grizzly Bears across their remaining habitats.

Listed as "Threatened" in the United States, the Grizzly Bear is protected under the Endangered Species Act there. COSEWIC identified 14 Grizzly Bear zones in Canada, and concluded that grizzlies are "Vulnerable" in seven, "Threatened" in one, and "Extirpated" in the two zones on the prairies where the grizzly is actually extinct. In 1991, Canada's entire Grizzly Bear population was formally classified as "Vulnerable." WWF believes the existing status decisions regarding Grizzly Bears by COSEWIC should be carefully monitored annually, so that they can be updated as necessary for the conservation of Grizzly Bear populations at risk.

Direct Killing by Humans

So far, no subpopulation of Grizzly Bears in Canada has been formally classified as "Threatened" or "Endangered." However, the grizzly is still regarded as a game species here and, as mentioned earlier, is the object of both spring and fall hunting seasons in some areas. Because of their slow reproductive rate, the killing of grizzlies, especially females, can have serious consequences for the species.

Habitat Loss

To ensure survival of the species and subpopulations, Grizzly Bear habitat must be protected, particularly den sites, critical feeding areas, and travel routes.

Access

Increased human access has had disastrous effects on Grizzly Bears, making them more vulnerable to hunting and poaching. Many access roads could be closed off.

Sanctuaries

It is important to establish conservation areas, to protect their cores, and to modify human activities around these areas.

Bear Attacks and Human Safety

Grizzly Bear behaviour is not well understood by many people, and grizzlies are often feared, which has led to their persecution. There are some insightful books on how to avoid people/bear confrontations, and it's important that people learn how to avoid and deal with bear attacks.

Government Cooperation

The four Canadian jurisdictions which still have Grizzly Bear populations, Alberta, British Columbia, the Yukon and Northwest Territories, must continue to coordinate their efforts in order to conserve this top predator.

Research

There are several important research needs in relation to Grizzly Bears. Developing better census techniques, determining the impact of hunting levels on some subpopulations, and better understanding bear behaviour are but a few.

THE BLACK BEAR

Indigenous only to North America, the American Black Bear is a creature of forested habitats. These forests provide den sites, food, protection, and escape from harassment. Therefore, the Black Bear's future is closely tied to whether or not some forests are left standing.

Black Bears are relatively slow-reproducing top predators, but generally reproduce more quickly than Polar Bears or grizzlies. The age at which females become sexually mature usually depends upon the quality of their habitat. For example, in east-central Ontario, where food supply is inconsistent, females don't have a first litter until they are between five to seven years old. On average, however, sexual maturity occurs at three to four years of age, with litters of two cubs, every two or three years.

There are a number of subspecies of Black Bears, but they're not always black. For example, the rare, white Black Bear—known as the Kermode (*Ursus americanus kermodei*) or "Spirit Bear"—is found only on Princess Royal Island, off British Columbia's north coast.

Currently considered Canada's most abundant top predator, with estimates of almost 300,000 across less than half their former range, Black Bears face a great deal of pressure from habitat loss, hunting, and now, a frightening new trend: the growing trade in Black Bear gall bladders and paws (Table 1). A bear's gall bladder is removed, dried, ground up into a powder and used in traditional eastern medicines. In 1991, the Black Bear was listed on Appendix III of CITES, which means that the legal international parts trade is now, at least, being monitored.

Blueprint for Survival

Conserving Black Bear Subpopulations

To ensure a future for Black Bears in Canada, protected areas must be established, which include the many natural regions, habitat types, and eco-regions that Black Bear subpopulations require.

Hunting Regulations

It appears that approximately 8% of Canada's Black Bears are legally hunted every year, which means that over 22,000 bears are killed. This is extremely high for such a slow-reproducing species, especially as other pressures on Black Bears increase. Hunting must be regulated more carefully, and spring hunting seasons should be eliminated.

Controlling the International Trade in Bear Parts

The listing of Black Bears on CITES Appendix III is a step in the right direction, but only with regard to monitoring, not controlling, the legal international trade. Therefore, Canada urgently needs clear legislation and strong enforcement at federal, provincial, and territorial levels to control or ban trade in bear parts throughout this country. The new federal Wild Animal and Plant Protection Act is also a step in the right direction.

THE WOLF

Wolves were once the most widely distributed mammal in the world. Now, in North America, wolves are found only in the more remote, timbered and tundra habitats. Even where they are numerous, they're rarely seen. Wolves require large expanses of wilderness habitats in which to live.

They are the fastest reproducing of these six top predators. However, wolves have a very sophisticated social structure dominated by an alpha female and male, which are usually the only pair that breed in a wild pack. Wolf packs are an extended family unit, mostly comprised of young from previous generations. Wolves are a "controversial" predator because they rely upon species for food which are also valued by humans—species such as Moose (*Alces alces*), deer, Elk (*Cervus elaphus*), and caribou. Because of agriculture, urbanization, and all-out predator killing programs, wolves have been eliminated from 95% of their range in the lower 48 United States. Canada is still home to approximately 50,000 to 60,000 wolves, occupying about 85% of their former range here (Figure 3).

Blueprint for Survival

Ethical Questions

Wolves are persecuted whenever they come into competition with people, much of it based on ignorance and fear. Human society must, therefore, confront some serious ethical questions as to whether or

Table 1. Bear parts trade activity and trends in Canada (Sheeline 1990).

Province	Trade activity in province (legal or not)	Legal to sell parts?	Trends in trade within the province	Parts goint to out-of-province destinations?	Local use of parts within province
Alberta	infrequent	yes	stable-growing	yes	yes
British Columbia	active	yes	growing	yes	yes
Manitoba	active	yes	growing	yes	yes
New Brunswick	active	no	unknown	yes	no
Northwest Territories	active	yes	none	yes	yes
Nova Scotia	infrequent	yes	stable	yes	yes
Ontario	active	no	growing	yes	yes
Quebec	infrequent	yes	growing	yes	yes
Yukon	active	no	growing	yes	yes

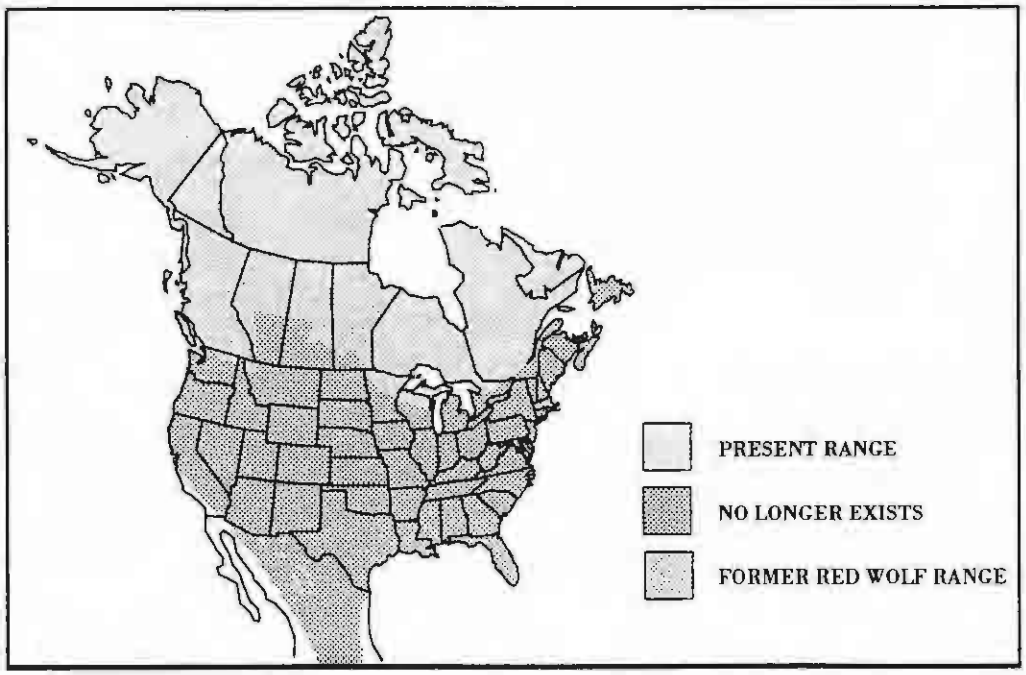


Figure 3. Historic and present range of wolves in North America.

not we are prepared to coexist with wolves in the wilderness.

Controlling Wolf Control

Wolf control programs, most often used to decrease the number of wolves in order to increase the numbers of deer, Elk, caribou, etc. for human use, must be subject to public scrutiny and process, if they are used at all.

Protected Areas

Presently, the combined area of current national and provincial parks, wilderness areas, and wildlife reserves protects only about 2.7% of Canada's estimated Wolf population, or about 1,600 Wolves. As Wolves are heavily trapped and hunted around the periphery of national parks, and hunted within most other parks, the adequacy of areas in Canada that protect Wolves must be reexamined.

Hunting Policy

In many Canadian jurisdictions, Wolves are hunted year-round with no bag limits. Hunting policies with respect to Wolves must be tightened up.

Recolonization and Wolf Recovery

In some cases, Wolves are naturally recolonizing some of their former range—for example, in Montana where Wolves have travelled south from British Columbia/Alberta. These efforts should be supported—rather than discouraged by increased trapping and hunting pressures in the Wolves' new range and place of origin.

Wolf Appreciation

Few people have heard the howl of the Wolf in the wild, but once heard, it's unforgettable. Wolf howling expeditions in Ontario's Algonquin Park, for example, are leading to a greater appreciation of this top predator. With care, this type of "wildlife viewing" could be duplicated in other jurisdictions, providing an economic boost to local communities.

Canadian Strategy

The IUCN Wolf Manifesto (appended in "Wild Hunters") urges the protection of different subspecies of Wolves and their habitats. A Canadian conservation strategy should ensure the future of all 17 subspecies of Wolves in Canada.

International Cooperation

Canada's continued cooperation with international bodies such as the IUCN Wolf Specialist group is important to the Wolf's future here at home and elsewhere in the world.

THE COUGAR

The Cougar, Canada's rarely seen wild cat, favours remote wilderness environments—not just mountain habitats, but foothill country as well. Unlike other top predators, female Cougars can breed during any season, giving birth to two to four kittens which will stay with their mother for up to two years. Of course, not all kittens survive to become adults. Because of this ability to breed in any season, it is always possible that kittens may be present if a female Cougar is observed or shot.

The Cougar's instinct, when it is in danger, is to climb a tree, which often results in its death if a dog and a hunter are involved. Hunters use dogs to track and "tree" a Cougar; the dog(s) keep the Cougar "at bay" until the hunter arrives to shoot it from the tree.

Cougar have been wiped out from nearly all their range in the eastern United States. Canada's Eastern Cougar is listed as an endangered species, and thought by some experts to be extinct. The only remaining viable Cougar populations are found in Alberta (with approximately 600 Cougar) and British Columbia (home to an estimated Cougar population of between 2,280 to 3,800). These two provinces share national responsibility for the fate of this wild cat in Canada.

Blueprint for Survival

International Guidance and Canadian Strategy

To ensure the future of Canada's Cougar, the IUCN Cat Specialist Gronp's international conservation document entitled, "Saving The Wild Cats" (appended in "Wild Hunters") should be used as a guide for Canadian wildlife managers to develop a Canadian strategy. This would ensure that healthy Cougar populations prevail in the west, while maintaining what may be a remnant population in the east.

Habitat Protection

Degradation of Cougar habitat is the greatest threat to Canada's Cougar populations. Protecting Cougar habitat, and the habitat of their prey, is extremely important for the future of this species.

Hunting Regulations

Although hunting regulations are currently being amended in both Alberta and British Columbia, it appears that Cougar have been overhunted in some management units. "Will-call" hunts should be banned. This is where an individual, on behalf of a hunter, tracks and trees a Cougar, then contacts the hunter who purchases a Cougar licence, and eventually arrives to shoot it. "Off-season" dog training should be controlled, and possibly banned in some areas of Congar range.

Control Programs

Historically, extensive Cougar control programs were used in the lower 48 United States and in some areas of Canada. These control programs, and Cougar bounties, should never be reinstated.

Public Information and Research

Expanded field research and more accessible public information on Canada's Congar would lead to a greater understanding of this elusive wild cat, and go a long way toward ensuring its future.

THE WOLVERINE

The Wolverine, a large member of the weasel family and the most mysterious top predator of them all, is a true wilderness inhabitant, found only in the most remote parts of our country. Wolverine are seldom seen by people, other than trappers and biologists who are studying them. Wolverine are legendary for breaking into trappers' cabins, and then spraying them with their strong smelling musk.

Scavengers by nature, Wolverine feed on carrion. Therefore, when other animals such as deer or Moose die from exposure or starvation during a harsh winter, the Wolverine have more to eat. Their reprodnction depends largely on food conditions, so the female will reabsorb the embryo if food is scarce. If food conditions are good, females may give birth to two or three kits, but even then, not every year.

A direct pressure on Wolverine in Canada is trapping, but trapping records do not suggest that this is causing a decline. So little is yet known about Wolverine biology, however, that it may not be safe to even say that.

Eliminated from the southeastern portion of their historic range, Canada's Eastern Wolverine (*Gulo gulo luscus*) population (east of Hudson Bay) was classified

in 1989 as "Endangered." Elsewhere, population estimates for Wolverine are difficult to determine, but they are thought at best to be a rare species spread out over large areas, and thus have been officially classified as "Vulnerable."

Blueprint for Survival

Canadian Population Goals

Since three Canadian jurisdictions are home to 75% of Canada's Wolverine. British Columbia, Yukon and the Northwest Territories, they share the greatest opportunity and responsibility to maintain still-viable populations of this vulnerable top predator. Other jurisdictions, particularly Québec, have the responsibility of hanging onto an endangered species—the Eastern Wolverine.

Trapping

The Wolverine is legally classified as a "furbearer," and government agencies regulate hunting and trapping accordingly. However, trapping must be strictly controlled, cooperatively or by regulation, particularly in the eastern part of Wolverine range.

International Trade

If more than 50% of Wolverine trapped enter international trade markets, the Wolverine should be placed on CITES.

Habitat Protection

It is very important to protect Wolverine habitat. Such an elusive, rare species is often overlooked when resource activities are being planned in wilderness areas.

Reintroduction

It is encouraging that Wolverine have shown an ability to naturally re-occupy former range (for example, in Montana). This should be further supported. Wolverine reintroduction programs are worth trying in areas where Wolverine were once found, where habitat is still sufficiently remote, and where their prey-base still exists. These areas must be protected if reintroduction is to be successful.

Research Needs

Wolverine continue to be the least known of Canada's large carnivores. Very few field studies were conducted on Wolverine, up until the last decade or so when WWF funded the first such studies in Canada. Research needs and public information on Wolverine are becoming urgent, as human activities alter what could be their last remaining wilderness landscapes.

A CONSERVATION STRATEGY

Although each of these six top predators is significantly different, some conservation steps can be taken which would benefit all of them. To accomplish this, "Wild Hunters" outlines seven strategic steps, based on WWF's Conservation Strategy for Large Carnivores.

Underlying these seven steps is a two-pronged approach. The first is a "preservation" approach: preserving natural habitats through the establishment of large protected areas with no industrial development. The second is an "integrated resource management" approach: modifying human activities on those lands and waters that are going to be developed and used by people, to ensure the long-term conservation of wildlife. The general goal of WWF's Conservation Strategy for Large Carnivores is: "To conserve viable, wild populations of large carnivores in Canada."

To accomplish this goal, the seven strategic steps are:

1. Determine population conservation goals. For each top predator, minimum viable population estimates (a still-evolving field of population ecology) have yet to be clearly determined. Preliminary estimates are offered in our book, "Wild Hunters." This information will be crucial to the long-term viability of Canada's large carnivores.

2. Establish Carnivore Conservation Areas (CCAs). CCAs are defined as "areas of sufficient size and managed in such a way to ensure long-term survival for free-ranging, minimum viable populations of large carnivores." CCAs are not places where large carnivores are conserved while they are wiped out everywhere else. Many CCAs can be centred or superimposed on already-existing protected areas.

A re-examination of Canada's existing protected areas network is required. Again, five preliminary areas are suggested for western Canada only, in "Wild Hunters." Are Canada's national and provincial parks large enough and being managed in such a way so as to ensure the long-term future of top predators? Are there other wild places where there's a possibility of establishing new reserves for Grizzly Bears, Cougar, and Wolverine?

3. Control killing by humans. Over 32,000 bears, Wolves, Cougars, and Wolverines are legally killed every year in this country, enough to occupy 37 (American) football fields if their pelts were laid-out side-by-side. And these figures do not include illegal kills. Clearly, legal hunting must be carefully regulated, and poaching reduced, or eliminated where possible.

4. Manage impacts on habitat. Each of these top predators is subjected to manipulation of its natural habitat, which can have a direct impact on its numbers. Each are also subjected to indirect impacts on habitat from industrial and agricultural activities, forestry operations, livestock grazing, garbage dumps, roads, etc., which affect distribution of prey species. All these, and other aspects must be understood, appreciated, and sensitively incorporated into the day-to-day operations of humans and their business when venturing into wilderness areas harbouring top predators and their prey.

5. Broaden public education. Reliable information should be demanded by and made available to people regarding the behaviour and ecology of top predators, especially given the misinformation surrounding these species. Only now are they becoming appreciated for their rightful role in ecological systems, and as symbols of wilderness.

6. Strengthen conservation research. More long-term research, including information on multi-predator/multi-prey systems, is crucial in order to avoid jumping to conclusions about predator or prey population trends based on a "snapshot" in time.

7. Improve cooperation. The importance of getting our governments to work together on the conservation of top predators cannot be over-emphasized. Efforts between the provinces, territories, and the federal government, as well as the private sector and academia, need to add up to enough to save these species on a national basis.

WHAT CAN YOU DO?

1. Speak up. "Wild Hunters" urges people to speak up, to be in touch with decision makers. Canadians have become very cynical about our political system, but if we don't have high expectations of it, we're likely to get exactly what we expect.

2. Join up. "Wild hunters" provides an extensive list of non-government organizations and government contacts to get people started.

3. Sign up. We urge people to sign the Canadian Wilderness Charter, part of WWF's "Endangered Spaces" Campaign, which calls for the establishment of protected areas representing each of the 350 natural regions of Canada by the year 2000. This would go a long way toward conserving top predators.

4. Read the regulations. We encourage people to become familiar with the hunting regulations for their area, by explaining how to obtain and read the them, through to what to look for in the way of hunting seasons and bag limits.

5. Learn more. We believe "Wild Hunters" will serve as a starting point to learn more. As well as outlining the historical and current biological information, we have incorporated quotes and anecdotes from forty scientists and other experts in the field, along with a full index and extensive bibliography.

6. Live what you believe. If everyone were more personally committed to recycling and reducing the resources consumed, believe it or not, it would be a big help to species as far away as the Polar Bear, Grizzly Bear, Black Bear, Wolf, Cougar, and the Wolverine.

Canada is a country where these top predators are taking their last stand. Therefore, it's very important to ensure that these species continue in viable populations into the future. After all, what would the earth be without them?

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MISFIT INSTITUTIONS, RATIONAL DECISIONS, ENDANGERED SPECIES

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To the fringes of the taiga, agricultural imperatives have come to dominate the rural prairie landscape. Once large-scale agricultural settlement commenced, in the mid-1870s, political and economic urgencies dictated the expansion of settlement at the maximum attainable rate. There was to be no methodical diffusion of agriculture, selective and adaptive, but, in large measure, a headlong rush by the overconfident leading and/or, pushing the ignorant.

Land was, after all, and since the emergence of feudalism in the lands of origin of the immigrant tide had been, identified with status, rights to it the prerogative of the aristocracy and the gentry. To homesteaders of peasant and proletarian background, ownership of land conveyed the promise of personal wealth and an upward surge in status absolutely unattainable in their countries of origin.

With the benefit of hindsight, the ecological consequences are readily discerned and easily determined to have been predictable. Even a cursory assessment reveals the dominant causes:

1. The urban proletarian elements which constituted a large proportion of the settlement tide were responding as much or more to dismal conditions in their industrializing homelands as to the prospects of land ownership and the vision of personal independence it conveyed. In the face of very limited alternative opportunities in a pioneer economy, commitment to an agrarian lifestyle was, for the majority, once arrived, not really a matter of choice, despite their lack of skills appropriate to decision-making in a totally unfamiliar physical and economic environment.

2. The settlers of peasant origin had behind them, in many cases, only one, and at most a few generations since their release from serfdom. The majority, in terms of their life-circumstances, had never progressed beyond the hard edge of privation. In their homelands, what survived of the natural landscape and its ecological legacy remained the private preserve of the gentry, interdicted to the peasant. The peasantry discerned no benefit to themselves from the wild creatures which inhabited such preserves, which to them appeared as a source of predation upon their crops and livestock. It need not surprise us that, in their new homeland, perceived or suspected predators, and their habitat, were eliminated as a matter of course, and by any means at hand. Parenthetically, it appears never, at an operational level, to have occurred to anyone that elimination of foxes, Coyotes (*Canis latrans*), hawks, owls, and other common predators, while sparing a few calves, lambs, and chickens, would unleash population explosions amongst their natural prey, with much greater economic consequences.

3. The majority of settlers of middle-class landowning background in Europe, eastern Canada, or the American mid-west were relative latecomers to the prairie pioneering scene, and brought with them a well-defined commitment to cash-crop commercial farming. Although, like that of their neighbours of proletarian and peasant background, their prior experience in milder, moister regions may have been minimally attuned to the rigorous prairie environment, they nevertheless came with capital and hence the capacity to project the machine age into the process of rapidly extracting the potential wealth accumulated in the soil through half-a-dozen post-glacial millennia or more. With the advent of mechanized agriculture, the drastic simplification of prairie ecology was assured and, very quickly, fact.

If certain feudal concepts of status associated with land were transplanted to the prairies, so were concepts in respect to the sourcing of public revenues. In pre-industrial time, land was the primary generator of wealth, the rights to it vested solely in the Crown, which handed off limited proprietary privileges to the aristocracy. The Crown informed its fiefholders of its revenue requirements; the aristocracy extracted them from the peasants bound to them. Real estate, together with taxes on goods, would persist as the primary source of public revenues. Taxes on newly-augmented wealth, that is on corporate and private net income, did not enter the revenue scene until the second decade of this century. When they did, however, as a progressive tax on the augmentation of net wealth, they were superimposed upon and did not supplant the regressive taxes on real estate. Relative to the rural

ecological reservoir that is at root of our concerns, this expresses itself as annually recurring impositions on privately-owned land to defray the cost of societal obligations and commitments most of which represent no reciprocal advantage or benefit, direct or indirect, to the land which must generate them or be forfeit to the Crown. When, in the late 1930s, in the wake of the great depression, government acted to in future protect individuals' basis of livelihood from precipitate foreclosure, it carefully exempted itself. In respect to levies in support of education, however, municipal governments are, to use the feudal analogy, the aristocratic fiefholders, and the school divisions the monarch. The school divisions have merely to communicate their revenue requirements to the municipalities, which are legally bound to extract them from the real estate tax base. This item alone characteristically constitutes 50% or more of the taxes assessed, and cannot be dismissed as a factor influencing the wealth-extracting procedures applied to the land, especially in light of the pervasive threat of forfeiture for failure to comply.

Near larger centres across the prairies, hamlets within the commuter radius have, in the course of recent decades, greatly expanded to become primarily dormitory communities. Their commercial base, however, has hardly grown, since shopping habits continue to focus on the larger centres. Within the commuter radius of Winnipeg, as a case in point, a number of such hamlets have grown to a size that would permit them to incorporate. None has. As integral elements of the rural municipalities, a significant portion of the infrastructural costs engendered by their expansion as dormitory communities can be laid off onto the agricultural land which reaps no benefit but continues to represent the bulk of the assessed, taxable real estate. At the same time, snch hamlets preferentially devour the best of the local ecological reservoir as preferred residential building and public recreational sites.

The assessment process recognizes several categories, based on the land's perceived ability, on a monetized basis, to produce wealth. So called wasteland, deemed incapable of producing such wealth, is assigned to the lowest monetized value category and hence is taxed at the lowest per-acre rate. Municipalities, in compiling the assessment notice, do not differentiate. They total all categories within a parcel of land to arrive at the assessed value, then multiply this by the mill rate to arrive at the current demand for taxes. The landowner is probably aware that, in varying terrain, the assessor has assigned various acreages to their different appropriate categories. Because his tax bill does not reveal these details, the landowner intuitively tends to average his tax burden over the entire acreage. This exaggerates the perceived imposition on the wasteland category which represents the bulk of whatever ecological reservoir survives in the vicinity. In any event the landowner is acutely aware that the natural produce of his wasteland upon which society-at-large has at all hothered to place a value is and remains the sole property of the Crown, which also reserves to itself the right, via licenses, to sell rights to that produce. Rational thinkers will, one would expect, have little difficulty in coupling the foregoing with the phenomenon of shrinking habitats and progressive local and regional endangerment and extinction of species.

Should the landowner elect to "improve" wasteland acreage whose appropriate "highest and best use" (to use the assessor's terminology, but not his criteria) would be to remain as it is, custodian of the ecological reservoir, he comes into imminent, if indirect benefits. Once it is mutilated beyond any capacity to fulfill its erstwhile ecological function, the Canadian Wheat Board, unencumbered by any concerns as to whether or not it can produce a cultivated crop, will unhesitatingly register such acreage as "improved," entitled to quota allocation and henceforth rendering economic benefits to the owner, if not in produce, certainly in terms of the rate of delivery and the quantity marketable from his productive acreage. Direct benefits may, moreover, be anticipated whenever the government, in economically depressed times, lends an improved acreage-based helping hand, such as the $5 per acre Farm Support and Adjustment Measures payment on "Canadian Wheat Board acreage" in January of 1992. Summerfallow, an acknowledged destructive, decertifying feature of our agriculture, will receive the "support" "after April 1, 1992." "Wasteland," the ecological reservoir, receives nothing.

Provincial crop insurance programs, by their terms of reference, promote the maximization of eligible acreage. So does the recently introduced federal initiative, Gross Revenue Insurance Plan. Of the federal and provincial programs directly impinging on agriculture, only Net Income Stabilization Act is relatively acreage-neutral. And yet, since the benefit formula is based on gross revenues, it too subtly encourages the appropriation especially of marginal lands, which have become the core of the remaining ecological reservoir, to the monetized production base.

The bulk of the immigrant tide that engulfed the prairies in the latter decades of the 19th Century and the early decades of the 20th had its origins in regions of moderate climate and abundant moisture, where mouldboard plowing dominated the tillage regime. Most crops were fall-planted. Mild winters and/or abundant snow cover promoted survival. Even the hardiest seedstocks imported to the prairies were, however, unable to survive the much harsher winters in the context of modest snowfalls, high prevailing wind velocities and the "obligatory" plow tillage which left nothing to break the wind and hold the insulating snow essential to plant survival. Spring seeding quickly became the inflexible rule in all but the chinook belt. So firmly was the futility of fall planting elsewhere on the prairies quickly ingrained that when rust resistance came to he included in the systematic search for improved varieties, the effort was entirely focused on spring-seeded crops. The chinook helt was not plagued by grain rust, and so fall-seeded crops were not brought into the program. Now, it is a myth that fall-seeded crops cannot reliably survive a prairie winter. Seeded into undisturbed snow-retaining stubble, existing varieties are quite hardy enough to survive throughout most of the so-called spring wheat belt. But, the existing varieties lack the essential rust resistance. Given the availability of even one variety of rust-resistant fall-seeded wheat, it can be confidently predicted that rationally applied economic and time-allocation considerations would quickly promote its adoption over a suhstantial proportion of the spring wheat helt. Such acreage would, quite incidentally but also quite inevitably, establish a blanket of habitat undisturbed until harvest, well past the subsequent nesting season. The question is, are we ready to accept and pursue "redemptive" results predictably, if incidentally, achieved as a side-benefit of "profane" exploits?

Recognition of several individual but mutually-reinforcing components of the ecological degradation/species endangerment syndrome induced by immigrant cultures alien to the nuances of our interior-continental environment is one thing. Devising solutions is quite another. One thing appears certain: In the main, an adequate level of success will hinge upon adjustments in background institutions to which the majority of proprietors of the ecological reservoir of the prairies—farmers and landowners—are constrained to make economically rational responses. Such adjustments must generate mutually supportive signals to decision-makers, culminating in retention, redress and retrieval with respect to the ecological reservoir, at little or no ancillary cost and hence immune to the pernicious implications of discount rate driven economics. With respect to the public as to the private sector, segmented jurisdictions and mandates contribute to the non-realization of environmental benefits and degradation of the ecological reservoir. Ownership of much of Canada's terrestrial and marine ecological resource-space continues to be vested in the Crown, which may grant usufruct rights under various forms of license or permit. As a case in point, rights to the extraction of timber are granted to producers of lumber, pulp, and paper. Clear-cutting is the dominant mode of exploitation. Reforestation, if undertaken, is single-species monocultural, coniferous.

One situation in which a major opportunity may be lost through adherence to "standard practice" is currently developing in the central and northern Interlake regions of Manitoba. Wood Bison (*Bison bison athabascae*) were introduced there in 1984, as a venture to augment the resource-base of the native population with a species which could colonize a hitherto vacant ecological niche. The bison have thrived, to tbe point that a release—so far successful—to the wild was achieved in 1991. Experience gained during preceding years has demonstrated that initial seeding of cutover areas to a grass-legume mixture greatly favours the bison. To retain the micro-climatic advantages of wind-shadow, individual cutover areas should be restricted to 1.5 to 2 km^2, preferably about twice as long as wide, with the long axis roughly at right angles to the dominant wind direction. With the appropriate adjustments to prevailing forestry practice, several thousand free-ranging bison at least could be accommodated in the central and northern Interlake, within the context of an improved environment for pre-existing wildlife populations in the same region.

Subsistence and commercial hunting, trapping, and fishing have heen a persistent fixture sharing the woodland resource and watershed base with forestry, but they have hitherto had to accept forestry's pre-eminence. Perhaps society should re-examine and fine tune that situation. A multi-tiered approach dedicated to the maximization of the sum of opportunities appropriate to all interests, not least of these the sustaining of the woodland ecological reservoir of diversity, appears timely.

As to the prairie sector, in which private ownership dominates, it will be necessary to imbue the various response-provoking factors with policies that emit signals which in sum elicit an ecologically positive

response. In attempting to formulate recommendations appropriate to that objective, it is wise to remember that initiatives that can be implemented entirely within the sphere of competence of a single level of government are less likely to falter than those requiring negotiation and reciprocal commitments up and down the municipal/provincial/federal escalator of competence and authority. Some concrete suggestions, not necessarily altogether consonant with the foregoing advice, are:

1. In respect to "unimproved" land, modify the Canadian Wheat Board regulations in such a way as to provide for quota entitlement, at least up to 25 or 30% of any individual farm's gross acreage. Equivalently, provide for retention of quota entitlement in respect to acreage retired from cultivation and committed to ecological reserve status.

2. Institute a zero-value assessment on wasteland within the municipal taxation system. Pro-rate the foregone revenues, on a municipality wide basis, onto agriculturally productive acreage or, preferably, achieve an offset through an increase in the number of points of the provincial income tax surcharge currently assigned to municipal revenues, thereby also acknowledging the stake that society-at-large has in an ecologically sound environment. Apply the revenue offset principle—perhaps at the 50% level—also to grazing and forage-producing acreage committed to non-disturbance until such time—likely in early to mid-July—as ground-nesting birds have brought off their first broods. A beginning needs to be made somewhere, to untax nature.

3. Institute detailed, explicit, categorized tax billings in respect to privately owned rural land, to counter the tendency of landowners to "homogenize" the levy into the average for an entire holding.

4. Mobilize the resources of Agriculture Canada in a high priority program to develop an acceptable strain of rust resistant winter wheat. It is not unrealistic, in the presence of this innovation, to visualize an annually recurring carpet of secure breeding season habitat across the spring wheat belt, greater in area than all the existing formal habitat enhancing and preserving programs combined.

5. Create a legislated framework within which landowners could, under caveat, commit any portion of their acreage to ecological reserve status without otherwise compromising the integrity of their title, but resulting in the removal of the acreage under the caveat from the municipal taxation base, and thereby further untax nature.

6. As a token of appreciation to landowners who informally maintain ecological reserves which favour populations of species in respect to which the Crown normally sells hunting licenses to all applicants, issue, on request, a complimentary, non-transferable personalized license. In respect to species subject to a limited issue of licenses, institute a parallel draw for complimentary licenses in respect to qualifying, habitat sustaining applicants.

7. Realistically, from political and economic perspectives, agricultural subsidies are likely to be a persistent feature of the rural prairie scene well into the future. It is difficult to devise support systems that are not acreage-sensitive. Free Trade and General Agreement on Trades and Tariffs (GATT) provisions are threatening conventional existing systems of subsidy delivery. To the extent that Free Trade and GATT interpose themselves between the Treasury and the farmer/landowner, ecological reserves and habitat enhancement fairly shout for attention as an elegant dodge. One thing is certain, the greater the extent to which individual rationally-made, ecologically uninfluenced choices can be construed to be incidentally congruent with ecological objectives, the greater our prosperity, individual and collective, will be. It may be as simple, and surely as dauntingly complicated, as that.

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AN EVALUATION OF THE PERFORMANCE OF ECONOMIC INCENTIVES TARGETED AT ENHANCING WILDLIFE HABITAT IN WESTERN MANITOBA

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The increased intensity of agricultural production in the past 50 years has had a large impact on the Canadian prairie environment. Approximately 40 percent of the natural wetland, 80 percent of the native prairie, and 75 percent of the aspen parkland habitats on the Canadian prairies have been destroyed. Agriculture is the primary force in this native habitat destruction (World Wildlife Fund 1988).

Market signals guide agricultural producers toward economically sound decisions. In the case of environmental services, which include the range of economic and social benefits provided by a healthy environment, these signals become distorted and ineffectual. As a result of the apparent zero market value of these services the producer is unable to incorporate these values into the economic decision making process. Therefore, environmental services are degraded as an unpriced cost of agricultural commodity production.

Agricultural management techniques which are less damaging to the environment can be made more economically attractive by implementing various incentives. Incentives provide the environmental service with an economic value which can be included in the producer's production equation.

The Habitat Enhancement Land Use Program (HELP) was developed to deliver incentives to landowners in the rural municipality of Shoal Lake in western Manitoba. The HELP incentives were designed with the goal of preserving and developing wildlife habitat in harmony with agricultural production (Morgan 1989). These two activities were formerly viewed as an either/or situation, primarily due to the existing economic policies and institutional arrangements associated with the agriculture industry.

The purpose of this study was to evaluate the economic impact that selected HELP land management options have on the participating landowner. In addition, landowner attitudes towards wildlife habitat preservation and the environmental problems associated with agriculture were qualitatively assessed. These findings were incorporated into an examination of how such incentive programs can contribute to a more environmentally and economically sustainable agricultural production system.

METHODS

The study examined only those HELP options which had participant landowners. A literature review and data from the HELP biological evaluation (Jones 1991) was used to appraise the potential wildlife productivity of the study options. A total of 26 participant landowners were interviewed during personal visits, or by telephone, between January 24 and February 12, 1991, to assess the perceived economic value of benefits and costs attributable to the HELP incentives and restrictions. This data was evaluated using basic statistical procedures to determine the economic impact of the incentive option on the landowner. Landowner attitudes and perceptions with respect to the HELP options, and environmental problems associated with agricultural production were collected during the interviews. This data was used to develop a qualitative assessment of option performance.

RESULTS

The HELP options targeted for this study were delayed cut tame forage, salinity barrier, rotational grazing, delayed cut native hay, and land idling. These were the only options which had participant landowners.

The HELP options imposed a range of costs and benefits on the landowner resulting from the relevant incentives and restrictions. The relative potential wildlife productivity and the relative economic impact of each of the study options is summarized in Table 1. The rating of the options is based on the relative performance of each option compared to the other options and compared to conventional management. For example, the delayed cut tame hay option provided fairly strong benefits to wildlife compared to conventional management as a result of the extra time provided for birds to complete the nesting cycle. This option imposed a fairly strong negative economic impact

Table 1. Summary of HELP option performance.

Option	Wildlife Benefits	Economic Impact	Economic Impact (Incl. HELP incentive)
Delay Cut Tame Hay	+ + + +	- - -	- -
Salinity Barrier	+ + + +	+	+ +
Delay Cut Native Hay	+ + +	=	+
Rotational Grazing	+ +	+	+ +
Land Idling	+ + + + +	- -	-

on the producer due to the decreased forage quality from the delayed harvest. The $12.35 per hectare HELP incentive provided was insufficient to offset the extra costs imposed.

The planting of saline tolerant grasses on saline land within cultivated fields also provided net benefits to wildlife. The saline areas formerly imposed a cost on the producer in the form of crop production inputs where there was no financial return. The salinity plantings provided an economic return in the form of forage on land that formerly imposed a substantial economic cost. In addition, there are long-run conservation benefits associated with arresting the steadily advancing soil salinity problem.

The delayed cut native hay option restricts the harvest of native hay (predominantly slough hay) until after July 20. The HELP harvest restrictions required no change in conventional management therefore there was no change in hay quality. An important cost is the loss of field efficiency when farming around these preserved native hay areas. It was found that the producer perceived cost of $48.18 per hectare of slough to farm around these areas was offset by the net value of the hay harvested off these areas. Many of the native hay areas would be un-economic to put into production, therefore the $9.88 per hectare HELP incentive was a minor economic gain for a management technique that would be carried out anyway. As such, the HELP incentive was insufficient to preserve a slough area if there was no returns from forage production.

Rotational grazing provided moderate net benefits to wildlife over conventional grazing management due to an increase in residual nesting cover. Rotational grazing management provided a net economic gain to producers even without the incentive provided hy the HELP program. Economic incentives may not be necessary to promote rotational grazing although technical assistance may be required.

Idle lands provide important wildlife habitat across the prairies. The majority of the areas idled through HELP incentives provided no economic returns to the producer in recent years and most of the subject lands were marginal for agricultural production. The $19.76 per hectare HELP incentive was cited as the main reason for including these areas in an idle lease. Using the hypothetical valuation technique for land use restrictions (Bishop and Heberlein 1979) the perceived compensation level necessary to preserve a hypothetical 4 hectare slough was $58.85 per hectare. The HELP incentive was insufficient to prevent producers from draining and clearing these idle areas. The incentive would be attractive only to producers with permanent potholes or areas of marginal land which would not be economic to convert to productive agricultural land. In contrast, idling potentially productive agricultural land would impose an economic opportunity cost on the producer which would not be offset by the HELP incentive.

The study surveyed 26 active producers, whose main source of income was primary agricultural production, and nine landowners whose main source of income was off the farm. Only 11 percent of these non-farming landowners cited purely economic reasons hehind their decision to sign a HELP lease. Wildlife was the most important reason cited by 55 percent of the non-farming landowners. This compared to 74 percent and five percent respectively for the active producers. The level of economic is far more important to effect a change in management by active producers than for non-farming landowners.

Soil erosion was considered the most important agriculture related environmental problem by 41 percent of the producers. In contrast, only seven percent of the

producers rated loss of wildlife habitat an important problem (Table 2).

DISCUSSION

Economic incentives designed to encourage the adoption of agricultural management systems which are less damaging to wildlife habitat have a range of impacts. The management change may impose a greater financial cost on the participant than equivalent conventional management. The economic incentives must be designed to cover these extra costs if the option is to be adopted. The incentives may be required to more than compensate the producer thereby allowing the producer to make an economic decision to adopt the conservation management technique.

An important component in the development of effective incentive programs is the contribution made towards an economically and environmentally sustainable agriculture. As discussed earlier, agricultural production has frequently ignored or been unable to include as a cost, the environmental damage or externalities resulting from certain production techniques. Incentives are an important tool in assigning value to these extra market costs.

The producer ranking of soil erosion, water conservation, soil salinity, and pesticide pollution far above the problem of loss of wildlife habitat by producers seems to reflect this economic system which ignores off-site costs. Soil erosion, water conservation, soil salinity, and pesticide pollution are perceived as imposing long-run or short-run economic costs on the individual producer. In contrast, the loss of wildlife habitat imposes no perceived economic costs on the producer.

In essence, this is a private cost versus social cost problem. When wildlife habitat is preserved on productive agricultural land the costs, including loss of field efficiency, the opportunity cost of unrealized production, and the depredation of crops by increased wildlife populations, are borne by the producer alone. The social benefits, the various environmental services provided by the preserved area, are enjoyed by all of society. If the area was converted to cropland the producer alone would realize the economic benefits while society would bear the cost of the lost habitat. In general, the individual is unable to assess the total social costs and benefits of development. In addition, the present set of government agricultural policies alter the price regime under which farming operates such that certain types of production are favoured beyond the efficient level in an undistorted commodity market. Policies operate in such a way as to increase unpriced off-farm costs while priced on-farm costs are lowered (Girt 1990).

In conclusion, the movement of agricultural production towards sustainability requires an assignment of values to non-market environmental amenities and off-site costs. The assignment of recognizable value to these costs will make systems which are less damaging to wildlife habitat or have habitat enhancing characteristics, more economically attractive to the producer. The assignment of value to these costs may be accomplished through a number of policy instruments including incentives. Assigning appropriate values to wildlife habitat is just one aspect of this accounting for costs. Wildlife programs may find it advantageous to incorporate other types of policy instruments and encourage government to incorporate directed policies beyond the program's scope. The most important step however, is to develop consistent policies aimed at making agriculture more sustainable and providing a socially and biologically optimal level of wildlife habitat.

Table 2. Producer ranking of agriculture related environmental problems (N = 26).

Environmental Problem	Primary Importance (%)	Secondary Importance (%)
Soil Erosion	41	35
Water Conservation	19	26
Soil Salinity	19	17
Pesticide Pollution	15	8
Wildlife Habitat Loss	7	8
Loss of Species Diversity	0	4

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ALBERTA'S WATCHABLE WILDLIFE PROGRAM AND ITS RELATIONSHIP TO WILDLIFE TOURISM

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INTRODUCTION

Since 1981, it has been well established that wildlife is very important to Canadians and the Canadian economy (Filion et al. 1983). Recent years have seen wildlife agencies across Canada and the United States placing considerable emphasis on documenting the significance of wildlife in a socio/economic context.

In Canada, the federal and provincial governments have cooperatively conducted the 1981 and 1987 Survey of the Importance of Wildlife to Canadians (Filion et al. 1983 and 1987). Some very significant findings have emanated. In 1981 and 1987 respectively, 16.7 and 18.3 million Canadians participated in wildlife related activities which directly contributed $4.2 billion and $5.1 billion to the national economy. From the 1987 survey, it is estimated that $4.0 billion is directly attributed to nonconsumptive wildlife related activities which includes primary trips, incidental trips, residential activities, participation in wildlife organizations, and maintaining, improving, and purchasing natural areas. Public support for maintaining abundant wildlife and preserving endangered wildlife has also increased from 83.3 percent in 1981 to 85.2 percent by 1987. Of particular interest is the amount of time and number of expenditures individuals have devoted to nonconsumptive wildlife related activities. In 1981, residential based activities, by some 12.3 million Canadians, generated an estimated $196.9 million in direct expenditures. In 1987, these same activities increased to 14.0 million participants and $324.9 million in expenditures.

From a wildlife tourism perspective, similar increases have occurred in primary nonconsumptive wildlife-related trips or outings. From 1981 to 1987 the number of days spent on primary nonconsumptive trips increased from 56.8 million to 74.4 million and total expenditures for these type of trips increased from $2.1 billion to $2.2 billion.

The overall results of these surveys have led many wildlife agencies in Canada and the United States to re-examine their policies and programs. No longer are they solely accountable to traditional client groups. New policies, programs, and strategies, are required to provide quality services for complex and diverse client groups while at the same time, maintaining a resource stewardship function. Wildlife agencies' organizational structures have and will continue to change in the '90s. Alberta is no exception.

THE EVOLUTION OF ALBERTA'S WATCHABLE WILDLIFE PROGRAM

In 1983 the Wildlife Branch of the Alberta Fish and Wildlife Division created a nongame unit. The unit was primarily responsible for managing nongame species, and secondly, to provide programming for nonconsumptive users. From 1983 to 1988 many significant achievements occurred in the area of endangered species and nongame management. However, program planning related to nonconsumptive wildlife recreation received little attention. In 1988 the Wildlife Branch was reorganized to reflect changing needs and priorities. As part of this restructuring, a Natural History Section, having two permanent staff, was established to primarily focus on the development and implementation of a nature appreciation program. By creating a specialized section within the Wildlife Branch, it paved the way for elevating the recognition and priority for nonconsumptive wildlife recreation to a level that was comparable to the hunting and fishing programs.

PROGRAM GOALS AND OBJECTIVES

Our first task was to develop a strategic plan which outlined goals, objectives, and mechanisms to enhance public involvement and participation in wildlife appreciation, viewing, and conservation. Five goals emerged:

1. An awareness goal to increase levels of public interest in and appreciation for the wildlife resource.

2. A recreation goal to increase opportunities and participation levels in the nonconsumptive use of wildlife.

3. An educational goal to increase the levels of public knowledge and understanding of wildlife species and their habitats.

4. An economic goal to increase the interest and participation in wildlife tourism in Alberta.

5. A conservation goal to increase public involvement and support in wildlife management programs.

To achieve these goals, objectives were established for each and include:

1. Public appreciation of wildlife: to develop wildlife interpretation materials for public brochures, pamphlets, magazines, and newsletters for promoting nature appreciation through mass media vehicles; to develop wildlife displays and information products to assist nature centres, zoos, museums, and other public venues.

2. Nonconsumptive wildlife recreation: to identify and promote wildlife viewing opportunities by publishing provincial, regional, and urban guides (books, pamphlets); to identify, develop, and manage a selection of designated high quality wildlife viewing sites on public lands; to work with other government and nongovernment organizations, agencies, and individuals to enhance their existing or proposed nature appreciation programs.

3. Understanding and knowledge of wildlife: in cooperation with urban parks, nature centres, schools, and the youth groups, design, conduct, and assist with wildlife education outings, study projects, and courses; to prepare and disseminate information packages and products on wildlife species' characteristics, distribution, abundance, and habitat requirements—these products will be available to educational programs such as outdoor recreation courses, nature centre courses, and school curricula.

4. Wildlife tourism: to design and implement market assessment and user behaviour opinion surveys for wildlife tourism in Alberta; to publish provincial and regional wildlife viewing guides to enhance tourism opportunities; to promote, encourage, and support wildlife tourism initiatives and projects which are of interest to local authorities (cities, towns, and municipalities); to provide encouragement, advice, and support to tour operators, guides, and outfitters in cooperation with Alberta Tourism.

5. Conservation: to encourage volunteer participation and support in programs and projects benefiting wildlife, e.g., Christmas bird counts, wildlife population and distribution surveys, and wildlife enhancement activities; in cooperation with other agencies, organizations, and local authorities, foster and promote wildlife conservation, values, and principles.

PROGRAM ACHIEVEMENTS

By far the most significant undertaking for the program was the publication of the award winning Alberta Wildlife Viewing Guide (Lone Pine 1990). The 96 page book describes over 60 of the best wildlife viewing sites in the province. Complementing the text are full color pbotographs and maps for each location. For each site, descriptions of species diversity, occurrence, habitat types, and significant features and landforms are included. The kinds of services and facilities at each site are also detailed in graphic form. To further enhance the readers appreciation, enjoyment, and understanding of wildlife, the book contains a section on photographing wildlife and wildlife viewing etiquette. To date approximately 10,000 copies have been sold. The success of this project is attributed to many factors. First and foremost, the project was cooperative-based having many supporting partners and volunteers. Participants took part in all aspects of the project, from site identification and evaluation to the design and writing of the book. Building a sense of common ownership by all was an important factor in its success.

As the viewing guide hit the retail book market, our program became officially launched and was renamed as Alberta's Watchable Wildlife Program. The Nonconsumptive Wildlife Recreation Program sounded like some kind of disease.

With the guide published, our emphasis turned to upgrading the interpretative aspects of wildlife viewing sites. Although the 60 sites were selected on the basis of having some existing infrastructure, it was recognized that both directional signage to access the sites and interpretive signs to enhance visitor enjoyment and appreciation would be necessary. In cooperation with Alberta Transportation and local municipalities, the majority of the sites have been upgraded with supplementary directional signage. Work continues with local authorities and site management agencies to upgrade their respective interpretative features.

In partial fulfilment of our goals and objectives pertaining to increasing public awareness and appreciation of wildlife, several promotional products have been produced including: a watchable wildlife display for shows and conferences; a directory of wildlife viewing references; a program brochure; and an assortment of pins, stickers, and crests. Staff have also made presentations to various public groups, schools, and public shows or events. Considerable emphasis has been placed on encouraging, in cooperation with the Edmonton Christmas Bird Count Organizing Committee, the establishment of Christmas Bird Counts across Alberta. Since 1986, the number of counts in Alberta has grown from 22 to over 50, a good indication of the growing interest in bird watching in Alberta.

To address our wildlife tourism goals, two major studies have been completed. In 1990, a study on "Marketing Watchable Wildlife tourism in Alberta" (HLA Consultants 1990), was conducted, the results of which suggest:

1. Albertans want a strong commitment to resource protection and management if wildlife viewing tourism is to be developed and promoted on a sustainable basis.

2. Albertans, particularly in the southern part of the province want an improved supply of, and access to, public lands supporting a diversity of viewable wildlife species.

3. Alberta Tourism should have an expanded role in land use planning particularly as it relates to travel routes, tourism resources, and protected areas.

4. Since non-resident tourists will demand a high level of expertise and service from wildlife viewing tourism operators, Alberta Tourism should assume a primary responsibility in fostering high standards and skills in the industry.

In 1991, an Alberta Resident Watchable Wildlife User Survey (Manecon 1991) was completed to determine resident preferences and impediments to wildlife viewing and to detail some of the associated socio-economic benefits. Based on participant activities in 1990 some of the highlights include:

1. Ninety-six percent of Albertans participated in various forms of wildlife viewing and appreciation, while sixty-four percent (64%) participated in a direct and purposeful way through activities at home (providing nest boxes, feeders, and food) or by taking trips for the specific purpose of viewing wildlife in the outdoors.

2. An estimated $350 million was spent on equipment (binoculars, cameras, film, bird feeders, etc.) to aid their wildlife viewing activities and an additional $583 million was spent for expenses related to wildlife viewing trips, including transportation, accommodation, food, and souvenirs. Total expenditures by Albertans for wildlife viewing ($933 million) is fast approaching a billion dollar a year industry—a significant contribution to the provincial economy.

3. Among 11 selected leisure activities, wildlife viewing was ranked fourth.

Much of the information gained from this survey has re-affirmed once again the importance of wildlife to both Albertans and other Canadians. Already we are beginning to see that the wildlife tourism industry is beginning to blossom. Many Alberta communities are beginning to assess the merits of the natural resources within and around their jurisdictions with a new philosophy of conservation and sustainable development. In an effort to diversify their local economies, wildlife tourism is becoming an acceptable alternative. Terms like wildlife tourism, ecotourism, ecomuseums, and natural history trails are becoming common place in both urban and rural communities. Some unusual alliances and partnerships are beginning to materialize. I have just recently reviewed an ecomuseum proposal which involves several north-eastern Alberta counties, nongovernment and government agencies. The project proposes a series of auto travel routes which link many communities together in a common goal of sharing and conserving their natural resources to nurture a potential tourism industry.

I would like to describe another example of how wildlife tourism can be a positive factor in protecting and conserving our natural resources. The town of Bonnyville, in northeastern Alberta, is bordered by the shores of Jessie Lake. Initially, Jessie Lake was perceived by many local residents as a murky, smelly, mosquito infested slough. To others, it was home to a diverse number of breeding and staging birds. Threatened by drainage and possible development, a local natural history and bird watching group have saved Jessie Lake from its inevitable fate. By holding public meetings on the wildlife and tourism values of the

lake, the group has convinced residents and town officials that the lake was worth saving and furthermore should be modestly developed to accommodate wildlife tourism.

In summary, it is extremely important for natural resource agencies to act not only as responsible stewards but also, to provide the necessary expertise and guidance in the development of nature appreciation programs and the wildlife tourism industry. Wildlife tourism is helping to underscore the value of wildlife to broad segments of our society. This type of activity can serve as a catalyst for providing public benefits and strengthening individual commitment to the conservation of wildlife for future generations.

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LAND ETHIC

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I'd like to thank the organizers of this conference for inviting me to speak on land ethics. I operate a mixed farm, with my wife and two sons, in the Miami area. Our farm is a mixture of zero-till and conventional tillage, cereal and special crop production, as well as conventional grazing and rotational grazing systems for our cow-calf operation. Our location on the Pembina Escarpment, with its vast wildlife population, makes co-existence a necessity as well as a pleasure. The farms in this area have, from the time of settlement, produced generations of wildlife enthusiasts, whether as hunters, self-taught naturalists, or just plain nature lovers. This influence and farmer concern for wildlife have certainly surfaced in the actions of our local soil conservation group, The Deerwood Soil and Water Management Association. Right from our formation eight years ago, we have attempted to incorporate programs benefiting wildlife along with our on-farm soil and water conservation activities.

In my opinion, it is not only an ethical decision to change our agricultural practices to benefit wildlife habitat. There are compelling economic reasons to do so. Deerwood Soil and Water Management Association's demonstration work promoting reduced tillage, trash management, shelter-belts, and water retention, as well as personal experience gained on our own farm from rotational grazing and comparison tillage systems, has convinced me that wildlife-friendly conservation practices make economic sense for our farm.

In the past, settlement and economics forced farmers to change the natural habitat to what it is today. Under traditional farming practices, we very efficiently produce a seasonal monoculture which, from a wildlife perspective, is a green desert where the crop grows for only 90 to 110 days. The grain is removed very efficiently, leaving little spillage, and all residue is worked down into the soil and incorporated soon after harvest. What used to be year round cover and food sources now has grouped cover for only three to four months of the year, making it totally uninhabitable for wildlife. We now have an opportunity, through soil and water conservation practices, to create a system of agriculture which is both more efficient and more beneficial to wildlife.

I think we are at one of those production crossroads which periodically occur in agriculture. Much like the replacement of horses with tractors, the movement to reduced till, or even zero-tillage, is made possible by technological innovations in tillage and seeding equipment and in good, effective post-emergence farm chemicals.

On our farm we have a tillage trial where, in the same field, we have compared conventional, minimum, and zero tillage over the past five years. We have experienced as much as a ten bushel per acre yield increase in the zero-till over the other two trials. This demonstrates the economic incentive to the farmer to move to reduced tillage practices.

The spinoff benefit of reduced tillage is the habitat enhancement which could potentially occur on the 13.3 million improved agricultural acres. The 1986 census shows a total of 19.1 million agricultural acres managed by only 27,336 farmers in Manitoba. The improved acres represent 69% of the total acres. The ownership data from the census also contains a message. Of the 19.1 million acres, 62.8%, or 12 million acres, is owned by farmers. Of the 7.1 million acres rented or leased by farmers, only 2.3 million acres is Crown land. This means that only 12% of total habitat in agricultural Manitoba can be accessed or policy-influenced by direct government intervention in habitat enhancement. The involvement and cooperation of farmers is therefore vital for habitat improvement. This must be the message that all wildlife agencies and the general public take from this conference.

While preparing for this presentation, my father suggested that maybe the real endangered species is the farmer. This past decade of erratic weather patterns, even more erratic interest rates (we saw our interest financing costs rise from 12% to 22% in one year in the mid 1980s), and the devastating international trade war has decimated our farm population, shrunk our communities, and caused major financial hardship on the farmers still out there. When you begin to compare our farming plight to endangered wildlife species there are many similarities:

Loss of habitat	versus	Loss of market access
Loss of food sources	versus	Low grain prices and high input costs
Competition from introduced species	versus	Export subsidies of European and United States governments

Farmers really could move onto the list of endangered species along with Burrowing Owls (*Athene cunicularia*), Whooping Cranes (*Grus americana*), and Swift Foxes (*Vulpes velox*). It's time for agriculture groups and wildlife agencies to cooperate and work to common objectives. We must remember that farmers and, by extension, all Manitobans are living with wildlife off the bounty of the same resource.

I heard Dr. Rounds interviewed on CBC prior to this conference at which time he stated that there is room in western Canada for both agriculture and wildlife. He offered as examples the North American Waterfowl Management Plan, the Prairie CARE (Conservation of Agriculture, Resources and the Environment) Program, the Habitat Heritage Corporation, and the marginal land programs of both federal and provincial governments, all agencies whose aim is to enhance wildlife habitat while at the same time providing economic incentive and assistance to the farmer as a partner in this endeavour.

We must not let ourselves get side-tracked into this no-win confrontational publicity arena of the extremist animal rights activists. There is too much good work to be accomplished in habitat enhancement with farmers and wildlife agencies working together. Through proper education and good communication, we must ensure that the general public has a clear understanding of this issue. We have too little time and too few resources to waste in futile confrontation.

DEVELOPING A PERSONAL LAND ETHIC

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I tried very hard to come up with a way to start a presentation about land ethics at a conference like this without quoting Aldo Leopold. I must confess to you that I could not. "A land ethic reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land." (page 258). That is how Leopold (1991) describes the land ethic in "A Sand County Almanac." When I hear that description, two phrases stick in my mind: "ecological conscience" and "individual responsibility."

A land ethic cannot concern itself solely with soil conservation, or with water management or with wildlife biology. It must consider all of these plus the other processes that are operating in the environment we are looking at. In addition, the development of a land ethic requires our commitment as individuals. It is not something that can be enacted in legislation nor can it be done for us by someone else. As an old advertising slogan used to say, "If you don't do it, it won't get done."

Now that may sound like a pretty heavy load to get hit with first thing in the morning, so perhaps we should see if we can break "land ethic," "ecological conscience," and "individual responsibility" down into more manageable pieces. Fortunately, we can get some help from Leopold there as well. As he developed the principle of a land ethic, his writings reveal at least some of the thought processes he followed. A couple of other selections from his writing may provide us with some guideposts as we work our way toward an understanding of our own land ethic.

To do that, we must first have a clear vision of what a land ethic is. Leopold left us this view of its fundamental underlying principle: "All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts. His instincts prompt him to compete for his place in the community, but his ethics prompt him also to cooperate.... The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land." (ibid., page 239).

If we agree with his view, Leopold is telling us that people must first recognize that their place is as a part of, rather than apart from, the natural order. We can probably all accept that on a philosophical basis. It may be more difficult to adopt in practical terms.

Most North Americans no longer have a direct link to a piece of the rural landscape. We have become predominately a population of urban dwellers; a people who, if we look at all, must search for the cause and effect relationships between our individual actions and the natural order. Our view of the world tends to become more narrowly focused as our age, educational level, and life experience increases. We become experts in auto mechanics, in soil physics or in waterfowl biology at the risk of losing our ability to see our place and the role of our specialty in the larger picture.

Our ability to develop a functional personal land ethic will also likely be influenced by economic considerations from time-to-time. It is not always easy to decide to make the ethical choice, especially if there is a financial cost associated with that decision. If we can accept those costs as a measure of our personal commitment to the necessity of developing a land ethic, it may make them easier to bear. If viewed as a personal contribution, those costs will at least provide us some feeling of self-satisfaction. If seen only as income foregone, they'll carry negative connotations and no redeeming features.

That's probably enough discussion, perhaps even more than enough, about the difficulties and costs of developing a functioning personal land ethic. It's time to look briefly at some of the positive steps we might take. Leopold helped to chart that course too when he said, "No important change in ethics was ever accomplished without an internal change in our intellectual emphasis, loyalties, affections, and convictions." (ibid., page 296).

Based on that thought, our first step should be to create a climate where individuals are prepared and able to demonstrate their commitment as easily as possible. Two areas of public concern, education and economics, spring immediately to mind as candidates for that sort of action.

As we have already seen, a simple increase in the volume of education does not necessarily lead to a more holistic point of view. We must also concern ourselves with educational content. Because a land ethic requires ongoing education for living rather than short-term learning for employment, our efforts need not be restricted to the customary elementary - secondary - post-secondary sequence of the formal education system. Nor need we limit ourselves to the teaching techniques normally associated with a classroom setting. Glen will be dealing with some of those other techniques in more detail in his presentations, so I'll leave the rest of that discussion to him. For now, it is sufficient to note that, while it is a necessary prerequisite, formal intellectual education will not, by itself, result in the development of a land ethic. If people are to be stimulated to act, intellect must be combined with passion.

People may also be stimulated into activity by the promise of a reward or the threat of a penalty. As a result, economic considerations could be used to encourage a movement toward a land ethic. As a society, we have taken some hesitant steps in that direction, particularly with respect to punitive measures for violations of pollution control legislation. I would suspect that we would almost unanimously agree that that approach has not been very effective. By their nature, those penalties can only occur after a violation has taken place; a violation which, in many cases, cannot be cleaned up. In those instances, no amount of money collected in fines can undo the harm already done.

To encourage people to develop their land ethic, it would seem to me that a system which rewards appropriate behaviour upfront would be preferable to one which seeks to penalize inappropriate actions after the fact. It may even be possible to combine both systems to produce a more powerful impetus for good. To use a very simple, urban-based example, why not combine incentive payments to those who recycle their household wastes with a clearly visible charge for the collection of non-recycled material? Would that not stimulate a more desirable situation than our current system which sees people pay to have recycled materials picked up and buries the actual cost of garbage collection in property taxes where it becomes an invisible amount?

I'm sure there are many other examples one could cite to illustrate the same point. Let me sum up the discussion on economic considerations with this thought: we must develop creative ways of making appropriate actions both economical and ethical wherever that is possible. Having said that, however, we must also recognize that the ethical choice will not always lead to an economic reward.

At the risk of leaving you with the impression that I have no thoughts of my own about this topic, I would also like to quote from another author who makes that point extremely well.

In "The Wheatgrass Mechanism," Don Gayton (1990) says this about "the earth bond," the term he uses to describe a relationship between man and the environment that is analogous to Leopold's land ethic: "Once I had a prescription for the earth bond. It was simple: I watched the sun rise in the morning and I produced food. The rest followed automatically. That option for my society is now gone, forever, and other means of recreating the earth bond must be found.

There is a balance in all societies between science and myth, reason and the imagination. Mine has its balance profoundly tipped toward the rational: it is not partial to explorations by means of concentrated personal insight and imagination, except within the very traditional and defined disciplines of poetry, painting, or theatre. If we are ever to renew our earth bond, a re-balancing must occur. New bonds with the earth can now only be forged by personal explorations that go far beyond simple analysis and concern, into realms of imagination and myth" (page 146).

Gayton has given us clear direction about what we must do to reestablish our earth bond; to develop our personal land ethic. There is, however, one question which remains to be answered. How do we test our actions to determine if they are appropriate? To answer that question, and to close my presentation, I'd like to conclude as I began, with a final reference to Leopold: "Examine each question in terms of what is ethically and aesthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." (ibid., page 262).

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THE LAND ETHIC—INSTILLING AND LEARNING TO LIVE WITH A LOVE FOR THE LAND

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The diversity of wildlife and the quality of the natural landscape helps to define Canada as a nation. The value placed on wildlife by its citizens reveals much about the nature of its people. The well-being of wildlife depends on how we choose to use the landscape or alter it to better suit our needs. Our land ethic, now and in the future, will determine the fate of most species of wildlife, not only those that are threatened or endangered today.

A land ethic is essentially a set of principles and beliefs that leads an individual to interact with the environment in a positive manner. There isn't a universal definition of a land ethic or how we might recognize someone who has such an ethic, but anyone who cares about the natural environment seems to have their own understanding of what it means to have one. Those who believe that they have a land ethic also believe that others ought to have one as well.

A land ethic in its simplest terms is a love for the land. It may manifest itself in different ways, but a love for the land is the key element in a land ethic. I have known hunters, trappers, fishermen, naturalists, and botanists to name a few in whom I have perceived a land ethic, but their different values often blinded them to the positive characteristics in others. Many naturalists cannot understand how a hunter could have a love for the land, while hunters may dismiss naturalists as emotional and unwilling to accept the harsh realities of life. Each have their own land ethic, but express it in a different way.

While those who have some semblance of a land ethic debate the finer points amongst themselves, there is still a large segment of society who have no land ethic whatsoever. They fail to see themselves as part of a natural system with which they must interact, like it or not. To make matters worse, a new generation is being raised in an atmosphere charged with environmental rhetoric, but most youngsters choose to spend their leisure time in the shopping mall, rather than in the woods or out on the prairies. Aldo Leopold's insights are as valid today as they were in 1949 when he wrote that "Despite nearly a century of propaganda, conservation still proceeds at a snail's pace; progress still consists largely of letterhead pieties and convention oratory. On the back forty we still slip two steps back for every forward stride" (Leopold 1966, page 222).

Those of us who are concerned about conserving wildlife have to be concerned with how other people think and how they interact with the landscape, because their actions have an effect on the things we care about. We care about what happens on the back forty even if the owner does not. If the private landowner has a land ethic, he or she will choose to use that land in a manner that will benefit or at least minimize the harm done to wildlife. That is good for wildlife, and good for the rest of us. If the citizen at large has a land ethic, he or she will ensure that our collective back forty (Crown lands) are managed to benefit or minimize the harm done to wildlife.

Although instilling a land ethic in others has long been seen as a worthwhile goal, the manner in which this is best done is still widely debated. Judging by the rate at which unfavourable landscape changes continue to be made by people, countless years of propaganda and programs seem to have had little effect. Various approaches have been tried and some have shown success, but it seems that the challenge of instilling a land ethic in others has yet to be adequately addressed.

LEGISLATION AND REGULATION

There may be some who believe that it is possible to legislate or regulate a land ethic. The "No Net Loss of Wetlands" approach in the United States is an example of using legislative authority in an effort to prevent both the private and public sector from destroying wetlands. This "Swampbuster" legislation has had some effect, but it has not been successful in forcing people to adopt a land ethic. Recent attempts to weaken this legislation indicate that there are still powerful forces at work which seek to undermine conservation initiatives. There are appropriate uses of legislation and regulation, but we should be mindful that hearts and minds are seldom won by force.

EDUCATION, EXTENSION, AND INTERPRETATION

If a land ethic cannot be instilled by force, then the logical alternative appears to be informing, provoking, and cajoling people to accept a land ethic. In spite of what those who would educate others say, what they really want is for others to think as they do and act as they might do. It is no wonder that such educators have had little real success. Efforts have been made to introduce environmental education into the school system through programs like Project WILD, and facilities such as the Fort Whyte Centre for Environmental Education in Winnipeg, but it may be another decade before we will know whether or not these approaches have achieved any real success.

Extension, meaning the extension of research based knowledge from field and laboratory to the public at large, has been used at times to help foster the development of a land ethic. The blizzard of information that the Manitoba Department of Natural Resources (DNR) used to throw at the public, however, has diminished into virtual nothingness in recent years. Information is important in developing a land ethic, but it alone will not succeed in effecting widespread change.

Interpretation is any communication process designed to reveal meanings and relationships of our natural and cultural heritage through first hand experience with an object, artifact, landscape, or site. Although I've been involved in wildlife interpretation for many years, I can't recall a single instance where the sorts of things interpreters spend most of their time doing has instilled a land ethic in anyone. Puppet shows, slide shows, nature house displays, interactive video, and other so-called interpretive events may have a role to play in nurturing a land ethic, but they don't generate the spark that is necessary to create one. People have to experience wildlife in a way that stimulates all of their senses—something that wildlife can only do in the context of its natural environment. The venue is as important as the animal itself.

HABITAT ACQUISITION BY THE PUBLIC SECTOR

If we can't buy our way into the hearts and minds of farmers, then there are those who would have us buy them out completely. The government must do what the private landowner is unwilling or unable to do. There are places of exceptional value to wildlife that should be held in the public trust, both for their value to wildlife and people. There should also be places where a tree ought to be able to fall in the forest without anyone hearing it, salvaging it, interpreting it, photographing it, carving their initials into it, or having to raise money to preserve it.

The fundamental question that has to be raised, however, is whether or not we believe ourselves to be rich enough to leave something alone. In order for the public sector to preserve a piece of land, it must first be proven beyond a shadow of a doubt that it is absolutely useless. There must be no minerals, no merchantable timber (unless it is on so precipitous a slope that it cannot be taken even by helicopter), no potential for agriculture, no likelihood of urban or industrial use, and so on.

Once land has been acquired by the public sector, continued vigilance is required to maintain the integrity of an area. Public lands intended for one purpose may later become multiple use areas, and slide into being multiple abuse areas without anyone really noticing. In the absence of a widely held land ethic, no public lands regardless of their designation will be safe for long.

FINANCIAL INCENTIVES FOR LANDOWNERS

Because public ownership has negative implications in rural areas, working with private landowners is often seen as a much better alternative to buying them out. One of many insightful observations made by Aldo Leopold was that "the land-relation is still economic, entailing privileges but not obligations" (ibid., page 218). The people who design habitat programs aimed at landowners accept that landowners are most often motivated by economic considerations and see little need to change that basic equation. The North American Waterfowl Management Plan (NAWMP) is based on the underlying belief that economic forces adversely changed waterfowl habitat over a wide area, and that economic tools can be used to effect positive change. At the risk of over-simplification, the idea is that if the farmer doesn't want to raise ducks on his land, we'll pay him to do it for a while and hope that he likes having them around so much that he'll leave things alone after the payments run out.

As Leopold pointed out, though, "We asked the farmer to do what he conveniently could to save his soil, and he has done just that, and only that. The

farmer who clears the woods off a 75 percent slope, turns his cows into the clearing and dumps its rainfall, rocks and soil into the community creek, is still (if otherwise decent) a respected member of society" (ibid., page 224). An example of such circumstances occurred in the late 1980s in Manitoba when wind erosion caused soil to drift into drainage ditches, completely filling many of them. In a move popular with local farmers, the DNR cleaned out the drains at public expense and then gave the degraded soil back to the farmer. There were no penalties to discourage poor soil management practices, and in the absence of a land ethic, no social sanction against this sort of behaviour. Financial incentives that promote conservation will work in the short term, but are doomed to failure in the absence of a land ethic in the long term.

HABITAT CONSERVATION BY THE CONCERNED CITIZEN

More by accident than design, there do seem to be a significant number of people who have a land ethic and have land with which they might demonstrate their beliefs. I have tried this "damn the rest of the world, I'll save it myself" approach and can share what I have learned from my experience.

I acquired a quarter section of marginal agricultural land near Langruth and another at Delta Marsh. Though it looked as if it both of these parcels were pretty much useless for anything, the variety of interest expressed by others in this land over the years has been astonishing. I've experienced trespass grazing, trespassing hunters (on foot, by truck, snowmobile, and all-terrain vehicle), nightlighters, seneca root diggers, and two incidences of arson. I began to believe that anything of value that I had managed to conserve on my property would eventually be taken or destroyed by others. Once again, it seemed that the only solution to these sorts of problems was to foster a land ethic in others.

I also learned that if your land is not only marginal for agriculture, but also deemed to be marginal for wildlife, you will be virtually on your own. There will be lots of free advice available from government and non-government agencies, but if you want to do something for wildlife on these types of lands, it will be at your own expense.

Programs like the NAWMP recognize quite correctly that he who tries to save everything saves nothing. The program targets its expenditures for those townships in Manitoba where there is the best potential for raising ducks. Outside of these areas, the Critical Wildlife Habitat Program may offer some assistance, but normally only for those lands that have tall grass prairie, and in the next few years, mixed grass prairie. Most of Manitoba's privately owned lands would not qualify for any assistance under the current array of incentive programs.

Incentives to clear or otherwise "improve" these lands, however, are available. Haying and grazing income can be written off against taxes and other expenses, while acquiring a wheat board permit book could open up a cornucopia of subsidies and assistance payments. It still pays to destroy habitat. If you want to preserve wildlife on these marginal lands it will cost you.

In spite of the economic disincentives to preserve wildlife habitat, people are digging into their own pockets to purchase recreational land and enhance it for wildlife. Hobby farmers and commuters are excavating ponds and planting native prairie gardens. A few commercial farmers are also setting aside marginal lands on their own initiative and foregoing income as a result. Some have even donated lands to the Habitat Trust or voluntarily protected them under the auspices of a variety of programs. Their land ethic transcends economic considerations, and they do these things because they want to, and enjoy doing it.

These individuals serve as role models and emphasize the benefits of a land ethic. A land ethic remains something everyone should have, and we should do something to see that it is instilled in others.

THE BIRTH OF A LAND ETHIC

In my experience, a land ethic is most often sparked at an early age, though some have indeed discovered it later in life. Recognizing that there are as many paths to the promised land as there are people, the common thread in the creation of a land ethic is a memorable interaction with wildlife. For me, it was an early October morning in Delta Marsh on a duck hunting outing with my father. I was too young to be carrying a firearm, but the sensory experience of the marsh as gaudy Mallards (*Anas platyrhynchos*) swirled around us is fresh in my memory even today. No one intended to instill a land ethic in me that day, but given the appropriate stimuli, the flame was lit.

My counterpart in Alberta, Tom Bateman, can relate a story with a similar result. Many years ago he organized an early morning excursion for a school group to watch Sharp-tailed Grouse (*Tympanuchus phasianellus*) on a dancing ground. It was the first time that anyone had tried such a thing in that school, so there were no rules that said it couldn't be done. They met at the school at the unheard of hour of 4:00 am and set out by bus in the cold darkness. The experience of Sharp-tailed Grouse on a lek, illuminated by the warmth of the rising sun, had a profound effect on those students, two of which later become conservation officers and another a wildlife biologist.

Whether it is a duck scrambling into the autumn air, Sharp-tailed Grouse dancing in spring, or perhaps an Elk (*Cervus elaphus*) bugling in the woods of Riding Mountain, this is this sort of wildlife experience that is most successful in sparking a lifelong interest in the natural environment. This is the point of ignition.

If we really believe that a land ethic is a worthwhile thing for people to have, then we should be developing more and better ways for people to experience wildlife in a meaningful way. The provision of high quality wildlife experiences is labour intensive and requires an intimate knowledge of where and when such opportunities exist. For most organizations, this type of interpretation doesn't increase the visitor statistics nearly as much as would a mall display or a winter carnival, and it doesn't lend itself well to regular working hours, so it seldom gets done. The most effective means of instilling a land ethic is seldom used by anyone in government sponsored programs. A land ethic is still more often than not instilled more by accident than by design.

One encouraging development is the small but growing number of guides and outfitters in Manitoba that are offering nature tours. Parents, teachers, or youth group leaders who have the wherewithal to take advantage of these services and are willing to pay for them, can do a great deal towards generating a land ethic in others. In the past people looked to governments to fulfil a need that wasn't being met, but in future, conservationists concerned about education will have to rely more on private initiatives. It isn't enough any more to sit back and say that the government should do something about it. We should do something about it. It is nice to see that some have taken the financial risk to offer opportunities for others to interact with wildlife. The necessities of financial viability, however, may raise barriers to participation that could be insurmountable by those who are not as well off.

CONCLUSION

As Aldo Leopold suggested many years ago, actions that serve the best interests of the individual landowner do not necessarily serve the best interests of the community as a whole. Instilling a land ethic in others is essential to the success of every initiative aimed at conserving wildlife and natural areas. No one is a born conservationist; conservation is something that is learned. Those of us who concern ourselves with conservation should ensure that opportunities exist to spark a land ethic in others and see that it is nurtured. We will not be able to force or cajole people to develop a love for the land, but we should provide opportunities that will make it as easy as possible for nature to take its course.

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LAND ETHICS - SESSION'S SUMMARY COMMENTS

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It is important to give people exposure to nature if they are to be expected to have some appreciation for it and interest in protecting and enhancing it. Children are especially important to influence through our education processes. They must be able to "see" and to have "hands on" experiences to develop their appreciation and understanding for nature. Too many school nature programs are "set apart" from the general school curriculum.

For adult education in conservation, the power of demonstration is a great tool. Field tours are invaluable.

There is a need for governments to change some of the many policies relating to land that are not "conservation friendly" or were designed with only a single, specific purpose in mind.

Many government programs lack true grassroots input in their planning and design, with resulting fragmentation and ineffectiveness in their delivery.

It is important for landowners to have a stake or investment in projects or activities that involve them or their land to ensure their long-term commitment to it.

Land survey requirements and subsequent costs restrict easy setting aside of parcels of land for conservation or preservation purposes. Effective, long-term conservation easements would be helpful.

In most everyone there is likely a spark of "land ethic" that can be nurtured to fruition with the proper stimulation.

People with a concern for the land and nature must not be disheartened that rapid change does not take place or that others with power are not "making things happen." Each person should go forth in their daily lives doing their small part in action, word, and deed to show and express their interest, commitment, and concern to land ethics—some of it will rub off on others they touch.

ENVIRONMENTAL SCIENCE AT THE UNIVERSITY OF MANITOBA

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I would like to restrict the few comments that I can make to the ways in which the University of Manitoba, and particularly the Faculty of Science at the University of Manitoba, has responded as an educational institution, and is continuing to respond to increasing environmental concerns.

I should like to preface my comments with the opinion that a very desirable precursor to formal environmental education is the creation and fostering of environmental awareness in pre-university young people. Without an appreciation for the beauty of natural systems, for the wonders of biological diversity, and for the elements of the interrelationships of the homeostatic function and structure of ecosystems, I suspect the motivation to enter into further educational programs may be lacking. Without an appreciation of natural systems, how can we expect young people to be concerned about their conservation?

To a very large extent I believe our schools are doing a marvellous job of creating this awareness as indeed are the environmentally friendly lifestyles that are increasing in many homes, but I believe that our universities represent a resource which can help in this process and I do believe that this happens in a myriad of ways. One way in which this happens at the University of Manitoba is through the activities at the University Field Station in the Delta Marsh, where annually close to 1,000 young people from schools throughout Manitoba visit for periods ranging from a few hours to a few days. Activities provided to these classes range from simple demonstration of the diversity associated with a Manitoba wetland to the provision of progressive environmental and ecological exercises. Our Field Station has facilitated this by the preparation of a handbook of possible activities that is freely available to all schools.

A thorough examination of the University of Manitoba's general calendar will quickly provide an indication of the breadth of environmental education that is available and the wide range of disciplines which have something to offer. In a recent internal document prepared by Dr. Tom Booth on environmental initiatives at the university, the author recognized somewhere in excess of 150 courses spanning the faculties of Science, Arts, Agriculture, Engineering, Education, Architecture, and Law. With a little guidance, undergraduate students could quite readily avail themselves of packages of courses in such areas as Environmental Pollution, Conservation, Environmental Toxicology, Natural Resources, Population Structure and Dynamics, Environmental Economics, Environmental Policies, and Environmental Management.

That this is the case should not be surprising for as the massive environmental issues of global climate change, ozone holes, freshwater and oceanic eutrophication, acid precipitation, resource abuse, deforestation, forest decline, extinction and loss of diversity, soil loss and degradation, population pressure, failure of traditional technologies, and the hazards of new technologies have become manifest, and as we seem as a species to have long surpassed the cultural carrying capacity of our little planet, the implications of all of this on a large diversity of disciplines have also become obvious. This has been fuelled by open public concern for the environment, the slow to dawn reality that growth cannot continue indefinitely in a finite system and some political endorsement of the notion that economic development and the environment are inseparable and that economic practices must be socially and environmentally sustainable.

There are many in society who point their fingers at universities and accuse them of being unresponsive to societal needs. I think environmental education is one area in which such an accusation is without justification, and I don't believe that the University of Manitoba is unique in its responsiveness. However, it is one thing to create a plethora of courses that deal with the many and multifaceted implications of environmental concerns, but it is quite another thing to organize some of these offerings into structured programs the students of which can identify themselves as environmental scientists, managers, or economists. It is also another thing to identify and in some cases even create the career openings for young people educated in any one of such possible programs.

The Faculty of Science and the university have recently attempted to redress these omissions by the establishment in 1991/1992 of a 4-year major Environmental

Science Program with an interesting 5-year cooperative option. The 4-year program is seen in Tables 1 and 2 and from this you will see that it is structured around three levels. The first requires a general background and literacy in a fairly wide variety of subject areas. The second requires that students obtain some intermediate depth in fewer areas and the third permits students to obtain greater depth still within biological, physical, or mathematical sciences. This is the program as it presently exists, but it is and will probably always be in some state of flux as areas of greater depth become defined and new ones become recognized as being worthwhile. By this program we have an ongoing solution to the absence of structured and integrated degree programs. But it does not address the second problem of identifying the careers that may be possible for our graduates. Just as the university has responded to environmental concerns by progressing towards the provision of environmental education programs, the labour market must also respond to the public awareness of environmental issues and many companies and organizations are doing this by developing new environmental policies. Resource oriented and manufacturing industries must, and some are, realize that the production and marketing of environmentally friendly products can be beneficial. Industrial technology must increasingly utilize environmentally harmonious processes and be increasingly cognizant of limiting undesirable environmental impact. In both the public and private sectors it is hard to believe that there will not be an increasing requirement for environmental assessment officers, researchers, and planners. That this is indeed happening is evidenced by the approximately 40 companies and agencies that have made an initial commitment to offer employment to students in our Environmental Science Program, making possible the cooperative option that I mentioned earlier. That cooperative option is presented in Table 3, from which you will see that in this 5-year program, students will interspace their course requirements with three to four work terms. The optimistic hope is that a combination of public pressure, real economic incentives, and the contribution of trained environmental scientists will see continued growth in the demand for employees with a strong environmental education—a situation from which we should all benefit, but perhaps more importantly a situation that may ultimately contribute to a less abused environment.

Table 1. University of Manitoba, Faculty of Science, Environmental Science Program.

BACKGROUND REQUIREMENTS
Introductory biology
Introductory University Chemistry
Elementary Statistics for Biological Sciences
OR
Introduction to Statistical Analysis
General Physics
Topics in Physical Geology
Introduction to Physical Geography
OR
Principles of Economics
Introduction of Numerical Mathematics
OR
Introduction to Calculus
OR
Vector Geometry and Linear Algebra
OR
Introductory Computer Science
OR
Introductory Computer Usage
Intermediate Writing and Research

Table 2. University of Manitoba, Faculty of Science, Environmental Science Program.

REQUIRED INTERMEDIATE DEPTH
Principles of Ecology*
Introductory Biogeochemistry
Pollution Biology
Environmental Conservation Issues
Ecological Impact Assessment
Conservation Strategies
Energy Sources: Physical Aspects
Environmental Geology
Introduction to Environmental Economics
OR TWO OF
Geography of Natural Hazards
Geography of Natural Resources
Energy and Society
Climatic Change

GREATER DEPTH
27 Credit Hours in Biological Sciences (Botany, Microbiology, Zoology)
OR
Physical Sciences (Chemistry, Physics, Geological Sciences)
OR
Mathematical Sciences (Mathematics, Applied Math, Computer Science, Statistics)

*Usually available as a summer field course

Table 3. University of Manitoba, Faculty of Science, Environmental Science Program.

COOPERATIVE OPTION*
(5-YEAR PROGRAM)
(MAY COMPLETE 4 WORK TERMS, MUST COMPLETE 3)

Year 1	Course Work
Year 2	Course Work
Year 3	Fall - Work Term Winter - Work Term Summer - Work Term
Year 4	Fall - Course Work Winter - Work Term Summer - Work Term
Year 5	Fall & Winter - Course Work

*Due to commence 1992/1993. Contingent upon funding.

ADULT CONTINUING EDUCATION AND FAST TRACK HEALING FOR GROWING ECOSYSTEMIC STRESS

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I am going to suggest that, as environmental pain grows, demand for learning by adults will increase dramatically. University extension programs and a host of other private and public information brokers are rapidly increasing and merging with the television, radio, video, and paper media. In closing, I will briefly describe my program entitled, "Encounters with Saskatchewan's Endangered Spaces."

IS THERE A DOCTOR IN THE HOUSE?

The litany of insults the human race inflicts on mother earth continues to grow day by day. A communal sense of concern, awakened during the `60s, has deepened to one of urgency and anxiety.

Human population mushrooming; harvest of forest, mineral, and petroleum prodncts trying to keep abreast of consumer demands for housing, automobiles, and a dazzle of technological gadgets; energy demands leading waves of pressure to dam rivers, build more nuclear stations, and coal burners; demand for wilderness recreation settings striving to keep pace with increased global mobility; outright pollution such as acid rain and oil spills; habitat losing ground to croplands, industry, and urbanization; biodiversity diminishing; erosion of the ozone shield; soil organic matter and nutrient content being sacrificed to fiscal ends. The list goes on and on as we discover in workshops such as these.

Add to that the broader, more profound complexities and inherent environmental risks of unequal wealth and technology distribution over the globe, increasing polarization of cultural identities and ideologies throughout the world raising risk of conventional warfare and the risk of nuclear warfare. We are suffering acutely from ecosystemic stress.

In our attempts to answer "why," to stop all this, we find that each location-specific wound with its immediate cause becomes dauntingly complex as we discover layers upon layers of more distant causes. The causes of circumstance are overlain by those of history, economy, and politics. These in turn are influenced by the very valnes we humans employ to wrest a sense of order from what would otherwise be chaos.

We need a doctor in the worst way!

A great deal of ecosystemic fever is generated at the interface of ecology and economics. "Sustainable development": we are familiar with this notorious phrase promoted by the Brundtland Commission. Classical economists are evidently up against the wall for a cure and sustainable development is their last ditch attempt to dissolve a petrolenm-based economy in clean, natural water. The Brazil conference aimed to raise this suspect cure to its zenith—upon a world stage of politicians.

In my opinion, the Brazil conference would do better by finding ways to overcome our loss of community. I don't mean community as in church community, or neighbourhood community, or national community, and I don't even mean global human community. But I mean ecological community—in which we share destiny, hopes, pains, and thoughts not merely with people but with wildlife, mountains, prairies, water, air, minerals, and weather. Allow me to quote Stan Rowe (Rowe 1992) in this context, "How curious that every right-thinking person condemns selfishness and egoism in the individual, and sometimes even in the ethnic group or nation, but never in the species as a whole.... We condemn apartheid in South Africa (and sometimes apartheid as practised against members of Canada's First Nations) but discrimination against animals and plants not needed for food or clothing is routinely practised for sport, for testing cosmetics, for investigating human diseases. Why so?"

The answer may be that we have lost our sense of ecological community, our sense of kinship, of respect, of love. Not just any doctor will do, we need a doctor who cares!

BOTTOMS-UP PLEASE: GOVERNMENTS MAKE POOR DOCTORS

I recently proposed to the Deputy Minister of Environment and Public Safety, of the new NDP (New Democratic Party) Government in Saskatchewan, that the province would do well to commence pro-actively preparing nested environmental master plans. I consider this to be an effective instrument to stop incremental suppression of ecologic concerns in favour of development initiatives; far better than reactively attempting to conduct so-called integrated resource management. Three representatives came to discuss this matter.

Following their words of encouragement and support, I learned that government is increasingly wary of top-down decision-making. Instead, it desires to build community support for new directions from the bottom-up. Leadership, in the face of social/environmental change, is risky and ineffective without involving all stakeholders in developing, carrying out, and monitoring government decisions.

The short of it was: don't look to government to hand down the medicine. Democratic governments make poor doctors.

This type of bottoms-up government was recently well demonstrated with the development of the Saskatchewan Round Table on Environment and Economy's Conservation Strategy. From the beginning, input was sought from a broad range of interests: mining, agriculture, transportation, wildlife experts, plant experts, water experts, forestry sector, etc. Although, to my mind, the draft strategy is deficient in content, the interactive, consensus building process must be applauded. It is a process which recognizes that the mind of each individual citizen is a spawning ground for innovative ideas and approaches. It is also a process through which participants learn to appreciate other ways of balancing environmental variables with personal needs and goals.

Dr. Ursala Franklin (Franklin 1990), during the course of her Massey Lectures of 1989, stated her theory of social change; I repeat it here because it nicely captures the spirit of bottom-up decision-making. She calls it Franklin's earthworm theory of social change. In her understanding, social change includes ecosphere healing and has a great deal to do with learning. She said, "Social change will not come to us like an avalanche down a mountain. Social change will come through seeds growing in well prepared soil—and it is we, like the earthworms, who prepare the soil. We also seed thoughts and knowledge and concern. We realize there are no guarantees as to what will come up. Yet we do know that without the seeds and the prepared soil nothing will grow at all. I am convinced that we are already in a period in which this movement from below is becoming more and more articulate, but what is needed is a lot more earthworming."

Bottoms-up government is earthworming. The government is no doctor, the cures start with you and I.

UNIVERSITY EDUCATION AND HARDENING ARTERIES

For both historical and structural reasons, the formal, degree-granting, format of mainstream university departments may not be the best vehicle for responding rapidly to the mushrooming learning needs about ecology and environment.

Most, if not all, institutionalized education sees "learning" in terms of its objectives or outcomes (Botkin et al. 1979). In this view, learning is the process of handing down information from the knower to the learner. This worked reasonably well during a time when change in surroundings was not readily apparent because it was slower and spanned several generations.

By this approach, education institutions were first established by governments of industrializing nations for the benefit of society. Such benefit translated roughly into tailoring graduates to fit into workplace niches. Reading, writing, and arithmetic were the foundation of early curricula because they most directly related to productivity and hence economic well-being. Education was seen to occur only during the early years of one's lifetime. You learn as much as you can handle, and then cross that one-way bridge like a right-of-passage into the workforce to become, henceforth, a contributing adult citizen.

Today, university and community college institutions continue to operate for the most part within this conceptual framework. Their success is evaluated largely in terms of number and species of successfully placed graduates produced at the end.

Today's university students, unfortunately, even were they to learn environmentally healthy values and

management skills, do not achieve management positions in society and government for another decade or more in the future. The critical question is, can environmental concerns wait that long. I believe not. The bottoms-up movement of the adult population segment concerned about the ecosphere's state requires a different learning environment.

The fact is, since the 1950s, adult learning demand has increased and is mushrooming today (Waniewicz 1976 cited *in* Thomas 1991, page 27). The reasons are complex: but, the globalization of the individual human mind, as a result of linking all spaces and places on earth by means of communications technology, appears to have much to do with it. With that globalization comes an increasing awareness of global connectedness and hence an increasing concern about the need for global management. In addition, responsible adults feel a growing sense of crisis, urgency. They want information now.

"People have always had learning needs, but these needs have increased greatly today. For most of recorded history, the environment in which human beings lived was determined primarily by natural events. During the past three centuries, however, that environment has become more and more subject to technological control...(and)...control by human decision. Acquiring the learning that will allow us to make such decisions wisely has become vital. Our learning determines our behaviour, and as our behaviour has become all-important to the survival of the planet, so has our learning. Indeed, we have discovered that we have to continue learning throughout our lives." (Thomas 1991, page 2).

Who will provide the education to satisfy this learning? The traditional departmentalized university or college may be unsuited. Their very structures of quite independent faculties and departments appear designed to suit, not so much the needs of learners as, the needs of those industries and professions who await their graduates. New approaches and concepts are therefore, slow to germinate and circulate unless these fit visions of the future held by industry and professions. The university institutional arteries are not nearly as pliable and flexible as they might be.

RUNNING ON THE FAST TRACK: THE FLEXIBILITY OF UNIVERSITY EXTENSION DEPARTMENTS

There appears to be a large-scale, rather silent education revolution underway today. In general, mainstream institutions are being marginalized by learner-driven privatization of education. This privatization is happening simultaneously along several tracks which, once identified, we easily recognize. The media have become immensely powerful information/education brokers. Not only television, but consider the wealth of radio programs such as CBC's "Ideas" or "Sunday Morning" which explore, in depth, a broad range of topics; consider the birth of the video market and the array of newspapers and magazines. Saskatoon's Star Phoenix Saturday edition introduced its educational section called "Prism" less than two years ago. It now offers 12 or more pages of information and commentary which is effectively adult education. A very wide variety of learning opportunities are offered by community associations, city recreation programs, churches, lobby groups, workplace in-services, and private consultants. Add to these, university extension programs, such as that of the University of Saskatchewan with which I am connected.

The diversity of extension programs can range all the way from multi-course certificate programs offered year after year, to one-time events such as conferences, workshops, seminars, or even over the phone direction to people or material learning resources. A great number of programs offered are short-term, much like a community course offered during evenings or on weekends.

A very important characteristic of extension programs is that they can be altered, adjusted, downsized, enlarged, started, and terminated virtually upon a moment's notice. This flexibility is paramount for closely tracking the rapidly evolving needs of adult learners. University extension departments have the ability to run on the fast track.

THE DOCTOR WITHIN US: ADULT EDUCATION AND MIDWIFERY

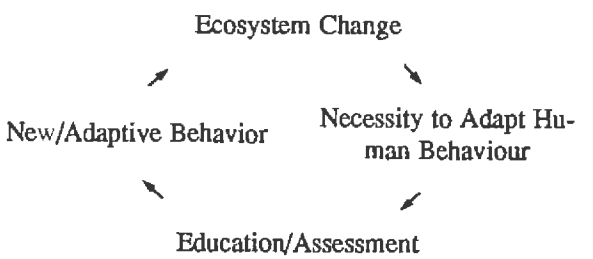
A clear distinction needs to be drawn between learning and education (Thomas 1991, page 17). Learning is the act of an individual driven by personal need, and education is the institutionalized answer to such

learning demand. To phrase it in terms of decision-making framework: learning is associated with bottom-up decision-making and education with top-down decision-making. Or again: learning is exploration for and discovery of new ideas and approaches, and education is delivery of set ideas and frameworks.

The important point here is that an increasingly large proportion of education is becoming learner driven as opposed to institutionally driven. The doctor is not out there; not in the government, not of the university or college. The doctor is within each one of us, you and I, searching for cures that ease the pain. The 1984 Council on Continuing Education Unit determined that the purpose of continuing education is to help maintain, expand, and improve individual knowledge, skills, performance, and attitudes, and by doing so, equally meeting the improvement and advancement of individuals, professions, and organizations. Therefore, a primary emphasis is on the individual learner (Mezirow 1984).

I want to add that the Saskatchewan Round Table on Environment and Economy's Education Advisory Committee deserves applause for recognizing the significance of continuing adult education forums as a means to spark its debates and exchange of ideas, and so to expand knowledge more quickly among the adult segment of the population. If we take the time to inquire, to learn, and to act upon our discoveries, then we will not need to blame the government in the future; or anyone for that matter.

Adult education then, is recognized as facilitating learning (Brookfield 1988, page 19). In this capacity, the adult educator has less to do with instruction than with midwifery; assisting the birth of new ideas and fresh approaches. Adult education departments are ideally placed to meet the demand for learning about environment, ecology, conservation, and a host of related topics and issues. It is an opportunity which I hope will be increasingly taken hold of across the globe. The following model describes the environmental change/adult learning cycle.



A 1987 Saskatchewan Education policy framework, Preparing for the Year 2000, identified seven principles to direct the future direction of adult (post-secondary) education within the province (Saskatchewan Education 1987). These principles, clearly written within an economic framework, are worth recasting (with very few alterations I may add) into an ecologic framework, and this makes them read as follows:

1. Adult education is the key to our future ecologic security. It must play a major role in a strategy for ecologic well-being in Saskatchewan.

2. As adult education and retraining become more of a necessity for future employment within an eco-centred economy, access must be provided more equitably to all groups and regions in the province.

3. Adult education is one of the main bulwarks against erosion of the ecosphere. We must reinforce this role.

4. The ability of learners to express themselves clearly and think independently is of critical importance.

5. The highest priority must be given by all adult education institutions to reinforcing analytical, conceptual, and reasoning skills.

6. There must be an expanded focus on the needs of older workers for retraining. Education must become a lifelong endeavour.

7. Adult ecological illiteracy is a silent enemy in our midst. Its eradication must be made a national priority.

ENCOUNTERS WITH SASKATCHEWAN'S ENDANGERED SPACES

I'll take a moment to describe, with appropriate humility, my program entitled, "Encounters with Saskatchewan's Endangered Spaces." It started last spring and is an ongoing ecosystem study. The overriding goal is to enable participants to bridge more or less abstract conceptualizations about ecosystems with real, hands-on field experience of their dynamics. The major sub-goal is for participants to develop stronger commitments and more informed approaches to protecting Saskatchewan's endangered spaces and habitats from threats.

The objectives of this program are that each learner will: 1) obtain an overview of Saskatchewan's

ecological zones, ecoregions, and ecosystems—their history and evolution, and their dynamics; 2) better understand how ecosystems function; 3) better understand the functions of organism species within an ecosystem as its environment; 4) understand how complex and variable ecosystem dynamics are in the field; how restrictive and tentative are conceptual models when considered in isolation; 5) appreciate the power of human endeavour to alter, truncate, and/or permanently destroy ecosystem functions and biodiversity; and 6) feel an awakening environmental ethic; feel a new sense of responsibility to be on guard against actions, in the professional workplace and/or at home, that threaten the ecosphere.

Although all interested people are invited to register, I most actively wish to target professionals, land-use managers, engineers, and planners. Most professionals are educated within traditional single-discipline settings and most are therefore, unschooled in ecology. As result, many are ecologically illiterate during a decade of increasing pressure to consider environmental consequences of workplace decisions.

The four foundational lectures which kicked off last year's segment on campus were subsequently published as a book entitled, "Saskatchewan's Endangered Spaces: An Introduction" (Jonker 1992). These lectures were followed by a day of visits guided by Professor Stan Rowe to sites in the Saskatoon vicinity which are representative of Saskatchewan's ecological zones. Subsequently, three overnight field excursions were conducted - Cypress Hills, Grasslands Park, and Athabasca Sand Dunes.

The program is multi-year in the sense that each year a new ecodistrict will be studied intensively, and participants will achieve a thorough appreciation and understanding of these areas and their dynamics over the years. The book serves henceforth as an orientation resource for each new participant in the program.

This year, June 20 to 28, the program will consist of nine days study of Boreal Forest ecology at Besnard Lake in north-central Saskatchewan. It will provide a complete and intensive ecology course of seven professors delivering the following schedule: day 1 - soils, day 2 - fungi, day 3 - insects, day 4 - small mammals, day 5 - large mammals, day 6 - forest birds, day 7 - birds of prey, day 8 - aquatic invertebrates and fish, day 9 - integration and issues. In addition, the program will include a presentation on the past and present relationship of Cree people to boreal forest ecosystems.

Although the days appear rather sharply and traditionally labelled, each instructor is challenged to deliver a program that: 1) is organized around a hands-on research type activity; 2) provides an overview of the range of organisms present in local ecosystems; 3) briefly describes how/why they are so distributed (i.e., with reference to geophysical cycles, habitat requirements, etc.); 4) addresses the effects of seasonal cycles; and 5) addresses some threats to select species.

Participants will come away not merely with abundant new knowledge, but also with a sense of wonder at the immense volume of activity that is occurring within an ecosystem at any given moment in time. The following year, 1993, it will focus intensively on grasslands ecology.

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PROGRAMS IN WILDLIFE BIOLOGY AND ENVIRONMENTAL CONSERVATION AT THE UNIVERSITY OF ALBERTA

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ABSTRACT

The University of Alberta has responded to the challenge of conservation with a growing number of environmental courses and the establishment of the Environmental Research and Studies Centre which coordinates campus-wide initiatives in this area. Two new degree programs, Bachelor of Science (BSc) Environmental Biology and BSc Environmental and Conservation Sciences, have been proposed, the latter for the 1993/1994 calendar. Strong post-graduate programs with specializations in Wildland Recreation, Wildlife Productivity and Management, Range Science, Rural Economy, Forest Science, Botany, Geography, and Zoology are available for Master of Science (MSc) and Doctor of Philosophy (PhD) candidates. The Faculty of Extension offers programs in Protected Areas Management, Environmental Education, and Agriculture and Forestry. Despite budget cuts, the University of Alberta is renewing its commitment to prairie conservation.

Courses in wildlife biology and management at the University of Alberta traditionally were offered through line departments. The first courses dealing with wildlife biology and management were offered by the Department of Zoology. But, with the establishment of a forestry program in the early 1970s, this lead was followed by a growing number of conservation courses in the restructured Faculty of Agriculture and Forestry (Table 1).

Table 1. Selected courses dealing with environmental conservation.

AGEC 435	Agriculture and forestry law
ANSC 376	Wildlife productivity and management
CNST 402	Canadian environmental policy and law
CNST 403	Environmental impact assessment
FOR 260	Conservation and recreational use of wildlands
FOR 365	Forest wildlife
FOR 372	Forestry and the environment
FOR 401	Wildlife impact assessment
FOR 462/3	Wildland recreation management/planning
FOR 464	Conservation/management of endangered species
FOR 472	Human factors in wildland resource management
GEOG 452	Arctic ecology
GEOG 466	Boreal ecology and northern development
LAW 553	Environmental law and policy
INTD 365	Natural resource economics
INTD 369	Economics of the environment
INTD 467	Heritage interpretation
PHIL 266	Philosophy of the environment
PLSC 356	Range/habitat management
PLSC 406/7	Range plants
PLSC 471	Rangeland management
RLS 452	Parks planning/management
SOILS 360	Soil conservation and management
ZOOL 260	Man and the biosphere
ZOOL 354	Wildlife diseases
ZOOL 467	Wildlife conservation
ZOOL 468	Problems in wildlife conservation

Despite long-standing interest in providing such courses, there always has been reluctance to develop specific degrees, majors, or specializations. The reasons may or may not have changed. The highly centralized nature of wildlife administration offered few employment opportunities for graduates. Most positions were filled with holders of advanced degrees, so emphasis was placed on graduate programs which built upon general degrees in Arts, Science, Agriculture, or Forestry.

An exception was the Grazing Management Program, an undergraduate specialization for students pursuing degrees in Agriculture or Forestry. This program prepared students for careers with agencies dealing with public lands, forests, and wildlife, or as ranchers, farmers, and agricultural extension specialists. This program has always been quite successful in placing graduates largely because they were given a broad practical background which offered a wider career choice.

However, the 1990s have brought restructuring of our program, partly in response to falling budgets and partly to perceived shifts in societal needs. A campus-wide Environmental Research and Studies Centre was created to coordinate initiatives in environmental teaching and research. The Faculties of Science and Agriculture and Forestry have proposed complementary new programs relevant to the conference theme; prairie conservation and endangered species. Both programs are under review and undoubtedly will assume a slightly different final form.

ENVIRONMENTAL BIOLOGY

The Departments of Botany, Entomology, Geography, and Zoology are proposing BSc specialization and Honours Programs in Environmental Biology. This will prepare students in the Faculty of Science for careers in ecology and related areas of the life sciences. The program will be implemented initially by drawing from existing courses. The anticipated enrolment is 10 to 15 students/year/class in the Honours Program and 30 to 40 students in the specialization program.

ENVIRONMENTAL AND CONSERVATION SCIENCES

The BSc in Environmental and Conservation Sciences is one of five new degree programs resulting from a major reorganization of the teaching program of the Faculty of Agriculture and Forestry. It will be offered along with baccalaureate programs in Agricultural Sciences, Food Science, Forestry, and Agriculture and Food Business Management.

Complementing the life science focus of the Environmental Biology degree, the BSc in Environmental and Conservation Sciences is a broadly-based degree emphasizing the integration of natural science, management, and social sciences as applied to environmental issues. Graduates will have the ability to evaluate impacts of land use and industrial activity on soil, water, plant, and animal resources and to implement conservation measures and remediation strategies for natural and damaged ecosystems. They will also understand the role of social, economic, and political forces in natural resource management.

Students for the five degree programs in Agriculture and Forestry will have a common structure including: 1) a common core of four half-course equivalents (HCE) to provide a broad university education, 2) a natural science or social science common core, and 3) a core for each degree program (Table 2). Students then select courses (up to four HCE program requirements and six HCE electives) from one of six areas of concentration.

Land Remediation, Reclamation, and Conservation

This concentration combines the natural and applied sciences with emphasis on understanding and minimizing anthropogenic impacts on the environment. Graduates will be able to design and implement programs to maintain quality environments and restore damaged ecosystems. Program requirements include: methods of environmental sampling and analysis; land remediation, reclamation; soil and water conservation; soil environmental chemistry.

Environmental Economics and Policy

Students choosing this concentration will develop skills in economic analysis of environmental problems and the policy process associated with environmental issues. Graduates will be prepared for careers in government and private industry in environmental economic analysis, policy analysis, and related areas. Program requirements include: natural resource or

Table 2. BSc Environmental and Conservation Sciences curriculum.

	Faculty core	Natural science core	Environ/Conserv science core	Environ/Conserv concentrations
Quatitative methods	9			
Communication	3			
English	3			
Basic life sciences	6		6	
Basic social sciences	3			
Economics (macro/micro)	6			
Ecology	3			
Engineering	3			
Systems/Conservation	3			
Human resource management	3			
Enrichment electives	12			
Chemistry		6		
Resource assessment			12	
Environmental impact assessment			3	
Environmental philosophy			3	
Environmental policy			3	
Environmental resource economics			3	
Concentration requirements				12
Concentration guided electives				18
Total	54	6	30	30

Single term course (half term equivalent, HCE) is 3 units. Students take 30 units per year for a total of 120 units in the 4-year program.

environmental economics, environmental law, and environmental policy.

Wildlife and Rangeland Resource Management

The Wildlife and Rangeland Resource Management concentration introduces the theory and practice of managing soil/plant/animal relationships. Students will have an understanding of multiple uses of wildlands and the integration of wildlife conservation with agriculture and forestry. This stream deals with means to increase the productivity and diversity of wild plants and animals. Graduates will be prepared for careers with government agencies or private firms dealing with management of wildlife, rangelands, and forests. Program requirements include: rangeland plants; range/habitat management; wildlife biology/management; rangeland systems.

Conservation Biology and Management

This concentration emphasizes stewardship of protected areas and critical ecosystems. The program emphasizes understanding, planning, managing, and communicating the complex ecological relationships of natural environments; securing their ecological integrity and facilitating, where appropriate, their use for outdoor recreation, ecotourism, and environmental

education. Career opportunities include government, environmental agencies, private corporations or consulting firms concerned with forestry, parks, nature reserves, recreation areas, fish and wildlife, or ecotourism. Program requirements include: environmental interpretation, protected areas management, conservation biology, protected areas planning, or endangered species.

Independent Concentration

In addition to the five formal counselling streams, students will be able to design a program which will match their special interests. This program must be pre-approved and based on consultation with an advisor.

Graduate Research and Training

Advanced degrees (MSc and PhD) in environmental conservation are offered by the Faculty of Graduate Studies and Research through the Departments of Animal Science, Botany, Forest Science, Geography, Plant Science, Rural Economy, Soil Science, and Zoology. Most departments do not have identified specializations but these submitted in at least three departments have specific designations: Wildlife Productivity and Management (Animal Science), Range Science (Plant Science), or Wildlands Recreation (Forest Science).

The University of Alberta always has had a strong northern focus facilitated by the Canadian Circumpolar Institute. However, as programs in sustainable agriculture and forestry strengthen, attention is turning to prairie ecology and conservation.

The University operates several field stations including the Meanook Biological Station in the boreal zone, Ministik Wildlife Research Station and Kinsella Ranch in the aspen parkland, and the R.B. Miller Biological Station in the southern foothills. These offer exciting research opportunities for staff and students.

EXTENSION PROGRAMS

The Faculty of Extension administers environmental extension programs in three areas: Environmental Education, Protected Areas Management, and Agriculture and Forestry. Besides hosting workshops and conferences on a variety of environmental themes, the Faculty of Extension has published a number of important titles on conservation and sustainable rural development.

FUTURE

Despite financial constraints and vertical cuts of several units and programs, the University of Alberta has reaffirmed a commitment to environmental research, teaching, and extension. A new slate of courses and two new degree programs await prospective undergraduate students. The graduate research program's strong northern focus is beginning to turn to the urgent challenge of managing the prairie landscape. By integrating environmental conservation into a professional faculty of agriculture and forestry, we hope to address the questions of sustainability raised by the Science Council (McEwan and Milligan 1991). In designing the curriculum for our environmental degrees, we hope to prepare graduates for future challenges (Romesburg 1991).

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THE ROLE OF ZOOS IN CONSERVATION OF ENDANGERED SPECIES

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HISTORICAL PERSPECTIVE

Over 3000 years ago zoos and botanical gardens had their first beginnings in countries such as China and Egypt. The purpose of these collections was not for any virtuous or intellectual reason, but they were mainly a symbol of power and wealth. They were simply collections of curiosities, in the same manner as these wealthy rulers collected jewellery or art. Botanical gardens were also collections, but had a higher purpose. Collections of plants were often associated with medicine and improvement of crop production.

Throughout the middle ages animal collections continued to be associated with royalty and private amusement or wealth. Botanical gardens became associated with research and education. What about aquariums? The collection and breeding of fish began in the orient and is of ancient origin. It is interesting to note that the fish were bred for the colours and patterns on their backs, since glass aquariums had not been invented, fish were housed in ponds and viewed from above.

Zoos continued to expand with the exploration of other countries and the building of empires. New species from new lands were shipped back to the capitals of the empire as curiosities, and even for public spectacles. But for the most part, these zoos were simply collections of animals. Little or no research was done on any of the animals and as they died, they were simply replaced by others from the wild.

Public zoos began with the advent of the Zoological Society of London in 1826 and the development of the London Zoo two years later. Given the conditions of the people of London during this time, it was not surprising that the zoo was seen as an escape and provided entertainment for the public. Some research was done in conjunction with these early zoos, but it was generally field research. Very little research was done in the zoo itself. As well, most of the animals came from the wild.

ZOOS TODAY

Today, public zoos are still in the process of change. There has been a definite shift from the purpose for entertainment to purposes relating to education, conservation, and research. This change is partly due to the public's demand for a more responsible manner in which zoos deal with their animals. It is not acceptable to have a zoo which is simply seen as a collection of animals for the sake of the collection itself. This is not to say all zoos are pure and wonderful. There are a number of ethical questions which even the most modern zoo has to ask itself, and there are still animal collections whose purposes are unclear and perhaps suspect.

ZOOS AND CONSERVATION OF ENDANGERED SPECIES

It is only within the last 15 to 20 years that zoos have taken a role of any kind in the conservation of endangered species. Breeding programs have existed for some time, but coordinated breeding programs aimed at sustaining animal populations for zoos is relatively recent. One reason for this relates to changes in laws which have restricted the movement of certain animal species. An example of this is CITES (Convention on International Trade in Endangered Species). It has become not only a moral issue to take animals from the wild, it has become a legal issue as well.

The moral issue has also helped to create the need for zoos to take a stronger role in conservation. There has been a trend for people to be more concerned with the welfare of animals as a whole. Caged animals were perceived as unhappy "prisoners" living their life in captivity, to provide amusement for humans. Zoos had to have a greater purpose. This helped to cause many zoos to rethink their mission and become more sensitive to a direction related to animal welfare, research to improve the conditions of zoo populations, research into captive breeding, conservation efforts, and education. This mission has evolved to where zoos are seen as "arks" for the preservation of some endangered species, and even more recently, as keystones in providing education to help conserve the planet.

WHAT ARE THE ZOOS (AND AQUARIUMS) DOING

Education

A key element of every modern zoo is their education program. Programs were once directed toward teaching specifics about animals in a formal classroom setting. This branched out to include more informal education or interpretation of the zoo animals to the general public, and to outreach programs. Today the modern zoo sees the educational mission as a key element of almost every facet of its operation. Design of exhibits is done with regard to its educational value, and all programming has an educational element. As well, the education theme has progressed from discussions specific to individual animals or species, to themes relating to environmental systems and the role man plays in these systems.

In 1986, the Association of International Zoo Educators resolved that it would adopt the World Conservation Strategy, and encourage all educational programming to include conservation education. Today many zoos have educational programs with specific themes relating to conservation, endangered species, and the wise use of our earth's resources. There is also an attempt to provide opportunities for the public to actively help with conservation projects.

One of the reasons that zoo education plays such an important role in conservation education, is found in the type of audience that comes to the zoo. Research shows that in North America, more persons go to zoos than go to all sporting events combined (estimated at over 25 million). Most of these persons are going to the zoo for recreation and entertainment. Very few go for an education experience. Therefore, through creative educational programming these people can be: made aware of their impact/relationship with the environment; can be induced (or seduced) to become interested in the environment; can be induced to do something about problems which face the environment.

This is a great, but important challenge. By showing zoo visitors an endangered species within their area, and by catching their imagination and interest, the visitor can be stimulated to care, and do something to help the species.

There are some excellent examples of zoo and aquarium educational programming here in Canada. The Vancouver Aquarium is a world leader in aquarium education and its innovative approaches are often followed by other major aquariums. An example is their aquatic animal "shows." These have evolved from true shows showing how killer whales do "stunts," to being one of the first aquariums to interpret these shows and change them to where today staged shows have been stopped and the whales are interpreted doing what they do naturally. The aquarium is a leader in the "systems approach" to education. That is their education/interpretive programs show the whales as part of a system, rather than as individuals. This is a critical element in conservation education; trying to get the public to think of the animal as part of an ecological system, rather than as a separate entity.

Some other conservation education programs taking place in Canada include education related to the Peregrine Falcon (*Falco peregrinus*) reintroduction program, Swift Fox (*Vulpes velox*) and Burrowing Owl (*Athene cunicularia*) programs, organized trips into the wilds at home and abroad to see the wild animal as part of a system, and recycling programs, to name a few.

RESEARCH

Captive Breeding Programs: The Zoo as a Modern Ark

Almost all zoos have some kind of captive breeding programs. Some of these programs are designed for the purpose of providing animals for sale to other zoos without depleting the wild populations. Other programs aim at trying to raise an endangered species for reintroduction to the wild.

Some examples of animals raised for this purpose include the Hawaiian Goose (*Nesochen sandvicensis*), the Golden Lion Tamarin (*Leontopithecus rosalia*), the California Condor (*Gymnogyps californianus*), the Swift Fox, and the Burrowing Owl. There are a number of others. The key to these programs is the reality of having somewhere to release the animals back into the wild as in many cases their habitat is minimal.

Conservation Centres

Some zoos have developed separate facilities to do reproductive research. An example of this is the Cincinnati Zoo's Center for Reproduction of endangered wildlife. The objectives of this centre are to: preserve

and propagate those plant and animal species that are, or soon will be, at risk of extinction; to set a standard for research in wildlife reproduction world wide; to provide a central focus for efforts that will one day link international conservation initiatives; to give testament to the fact that the people of the Cincinnati Zoo care enough to provide this vital stepping stone to our children's future.

Research in the Wild

Places like the Zoological Society of New York have a history of doing research in the wild relating to endangered species. An example of this is the work of Dr. Schaller relating to the Giant Panda (*Ailuropoda melanoleuca*). Persons from Calgary and the Calgary Zoo have worked in China assisting with projects relating to the Giant Panda. Many zoos cooperate closely in field research undertaken by their provincial departments of natural resources both in Canada and the United States.

Sponsoring Research or Programs Related to Endangered Species

A number of zoos help collect money for research or other programs, or provide funding for research. As well some of the zoological organizations such as the American Association of Zoological Parks and Aquariums (AAZPA) or American Association of Zookeepers (AAZK) promote and fund conservation research and projects.

Examples include the AAZPA's Conservation Center which acts as a coordinator of conservation projects on behalf of a number of its member zoos. In 1990/1991, 69 AAZPA member institutions sponsored 388 projects in 63 nations on six continents. These included 131 species specific projects (conservation, ecological research, reintroduction, and management); 82 projects related to habitat conservation, 45 projects relating to education; and 69 projects relating to rescue and reintroduction of native wildlife.

Other examples are AAZK's Bowling for Rhinos program which raises money to help protect the Black Rhino (*Diceros bicornis*) in the wild, and their Ecosystem Survival Plan program raises money for habitat conservation in cooperation with the Nature Conservancy.

SPECIES SURVIVAL PROGRAMS (SSP)

The SSP, although somewhat controversial, has been designed to attempt to coordinate international breeding programs so as to maintain the genetic diversity among endangered species in captivity. It is based on cooperation of the zoo community and the fact that the animals, that are part of the program, are shared amongst the zoo community. The animals are loaned between zoos so that the best possible matings can occur.

The program is administered by the AAZPA. There are approximately 54 species of animals listed as part of the SSP program.

STUDBOOK

The studbook is another way of keeping data of animals in zoos to enable lineage analyses and to maintain gene pools. There are approximately 36 species in which International Studbooks are kept, and approximately 73 species which have North American Studbooks are kept.

DO ZOOS MAKE A DIFFERENCE?

Over the last decade, zoos have been taking a more responsible role in the conservation of endangered species, and it can be argued that they are key to helping to preserve endangered species.

A discussion followed centered around this paper's presentation of the value of zoos for the conservation of animal species. Although some questioned the realistic value of that role in the long term, many persons felt that zoos could play a crucial role in conserving the breeding populations, and in helping to make the general public aware of the need to preserve our earth's ecosystems so the wildlife has somewhere to live.

CONSERVATION RESEARCH IN THEORY AND PRACTICE

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SUMMARY

The contribution of research toward biological conservation is limited because: 1) decisions regarding the environment are usually made outside of the realm of science (e.g., Aikenhead 1985), 2) science, even at its best, has pertinent limitations, and 3) the structure and reward system within which scientists operate does not fully encourage the practical application of science to solve societal problems. The premise of this presentation was that recognizing and understanding existing limitations is constructive. The following is not meant to suggest that the scientific way of knowing should be rejected, but to caution that too much reliance on this way of knowing alone can be detrimental.

Western society's reductionist approach to science is one in which a system that is too complex to comprehend in its entirety is reduced to smaller parts. These parts are then subjected to experimental manipulation aiming to identify basic forces, their relative strengths, and their interaction. This assumes first of all that complex natural systems can be understood and that all knowledge converges on "one truth." Problems with the reductionist approach can arise at many levels. In theory this approach, comes into conflict with the "modern view on science" which postulates that: 1) no part of a biological system exists in isolation, 2) unlike machines, living systems are in a constant state of change, 3) changes in living systems occur as a result of a balance between anabolic and catabolic forces, 4) the accumulation of small quantitative changes can lead to a qualitative change, and 5) the whole is greater than the sum of parts as a result of the interaction of parts. For example, if biological systems do not exist in isolation, this raises questions about the validity of forming conclusions based on the study of a part of a complex system. T.S. Kuhn (1970) provides a partial solution to this problem by suggesting that individual scientific conclusions can be contradictory, but in their entirety they can combine to reflect reasonably reliably on a larger concept or paradigm. This has relevance for the conservationist, because it would lead one to rely less on the so-called "scientific facts" arising from individual studies and more on the larger concepts which can be used to formulate conservation strategies.

The reward system that has evolved to support the scientific enterprise does not fully lend itself to the solving by scientists of societal problems (Barnes 1988). G. Holton (1988) divides science into many facets, distinguishing among others between sociological (pertaining to norms and values cast by scientists for scientists) and cultural aspects (pertaining to society as a whole). Historically, in order to survive in the tumultuous Middle Ages, the emerging scientists were forced to abrogate their responsibility in matters of the state and the church (Mendelsohn 1976). It is probably for this historical reason that many modern scientists feel that it is their sole responsibility to seek to understand an "objective order of reality" and not to question the supernatural, nor to intertwine the scientific endeavour with societal/cultural problems. Many scientists are reluctant to become fully involved in attempts to solve problems that are perceived by society as a whole.

It is probably no coincidence that humans in western society, who sought dominion over nature, placed great value and confidence in the scientific way of knowing. The assumption that knowledge affords power is inherent in an attitude toward nature that can be referred to as "geodominance." Increasingly, there are calls from people in all walks of life for a shift in thinking from geodominance to "geopiety." This shift in thinking, which is pioneered in elementary and secondary education, should also take place in bigher institutions of learning including the scientific community.

Human dominion over nature has proceeded so far with effects so devastating, that in order to conserve the diverse biological life on earth, conservationists must act before they can hope to understand (even if this were possible) the system they aim to preserve. In many cases, a call for greater understanding with the hope to dominate a system, knowingly or unknowingly, thwarts progress in conservation. A cautious approach to resource use and critical examination of human action toward nature may promise more success than our heretofore espoused aim to use science to

dominate nature for human benefit, and at the same time try and use the perceived power of science to keep the life support system alive.

Conservationists, or that segment of society that has a primary interest in preserving the earth's life support system and biodiversity, should assume the power that is now largely vested with scientists. It has been wrongly assumed that "good conservation strategies" flow directly from "good science." Applied engineering knowledge also did not flow freely from the disciplines of chemistry and physics; the practical application of strategies appropriate for engineering required its own knowledge system (Vincenti 1990). Conservationists should devise strategies by relying partially on science but more importantly incorporate other forces from society (the power of the individual, legal institutions, financial institutions, political institutions, industry). Conservationists should form a new social and professional entity and develop strategies for greater harmony between humans and nature.

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THE IMPORTANCE OF RESEARCH IN CONSERVATION

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The message of this paper is that research is the cornerstone on which all conservation action should be based. Conservation action, in the absence of a sound scientific basis, though well-meaning, may have deleterious consequences.

To build the argument, let's consider some definitions. First, what is research? To some, it is a very general term that describes the process of finding an answer to a particular question or problem. Quite a range of activities can fit into this broad category. For instance, discovering which gene is responsible for the onset of arthritis is clearly research but so is checking the "T.V. Guide" to see what time the hockey game is on tomorrow.

To others, research is a specific process, the application of a particular methodology, called the scientific method, for answering questions. The method consists of: (1) the defining of a testable null hypothesis; (2) the assessment of alternative explanations or hypotheses; (3) the collection of data to test the hypothesis; (4) statistical evaluation, of the data; and (5) statement of conclusions which either rejects or provide support for the null hypothesis. Interestingly, this doesn't exclude the T.V. Guide as a research tool. Our testable null hypothesis might be "That the frequency of Star Trek repeats is no different than the frequency of appearance of new episodes." Checking the T.V. Guide for a fixed period of time, we can determine the number of shows in each category, transform the frequencies to approximate a normal distribution, perform a t-test or equivalent and evaluate our hypothesis. This may not be science, but it is research.

A useful way to categorize research is to consider three types.

Summative Research

The consultation of bibliographic sources—a literature search.

Applied Research

The collection and analysis of data following an existing methodology or protocol. Examples are the collection and analysis of visitor survey data in a museum, or the collection and analysis of breeding bird survey data.

Basic Research

Despite the adjective, this is original, often complex, work where the collection of data may, or may not, follow an existing protocol, but the question being asked has not been answered previously. Examples would be the investigation of taxonomic relationships among a group of birds using a new molecular genetic technique, or an assessment of why female owls are bigger than male owls.

Why spend so much time on the definition of research? I think it is necessary to avoid arguments about the value of research based solely on different interpretations of the word.

Let's look briefly at summative research. I doubt there is anyone who questions the value of a thorough review of the literature prior to undertaking any conservation project. Certainly, in Canada, we can benefit from American or European experience in forest and grassland preservation. I know a few people who would suggest that, looking at how others have attempted to answer a question, might stifle their own creativity. Sometimes you hear of people being too close to a problem to see an easy solution. While this may happen on occasion, I suspect that it is the people who are close to a problem that would realize the value of an outsider's suggestion. Using a trial and error methodology, without taking advantage of existing knowledge, is invariably a waste of research time and money.

To assess the significance of applied research, I'd like to consider the value of studies which simply

document the occurrence of species in a particular region. An interesting comment comes from an early publication on Canadian birds. Montague Chamberlain of New Brunswick compiled the first *Catalogue of Canadian Birds* in 1887. In his preface, he states "This latter portion of the work (on geographical distribution) has not been accomplished very satisfactorily, for, although considerable labour and care have been devoted to the preparation of the notes on distribution, they are not at all complete, and I fear that on further investigation, some of them will he proven incorrect. All the information that is now obtainable has been procured. But the greater portion of the country - immense stretches of forest and prairie and sea coast - have received little attention from Ornithologists. I am quite aware that this opinion regarding the narrow limits of our knowledge of Canadian Birds is opposed to that held by some of the leading scientific men of the Dominion, who consider that all that can be learned about our fauna is now known to science."

We can all chuckle self-indulgently at the arrogance and ignorance of whoever these "leading scientific men of the Dominion" were. But what would be the response of granting agencies today to a request for research funds to support distributional studies on the birds of Alberta? I suspect they would sound much like their counterparts of a century ago. To what extent do we know the distribution of the breeding birds of a province like Alberta? Back in 1887 we would have used Chamberlain as our authority. More data and collections from Alberta were brought to light by Macoun and Macoun in 1909 for inclusion in their *Catalogue of Canadian Birds*. Egg collectors and Percy Taverner's collecting efforts in Alberta provided material for his 1926 *Birds of Western Canada*. Thirty-two years elapsed before the next compilation of *Alberta Birds* hy W. Ray Salt and Bert Wilk. Godfrey in 1968 in his *Birds of Canada* referred to only 13 papers on the distribution of Alberta birds written after Taverner's book in 1926. Minor changes were added in 1976 for the last revision of the *Birds of Alberta* by Salt and Salt. Now we have the *Atlas of Breeding Birds of Alberta* (Semenchuk 1992).

What strikes me is that there are relatively few studies which document the breeding bird distribution in the province. It is fair to say that about 20 major papers have supplied the bulk of information appearing in the most recent guides. Part of this has been the result of a shift in emphasis from "Birds of" types of studies to ones detailing breeding ecology, physiology, behaviour, and systematics. The feeling back in 1887, that we know all we need to about this aspect of Canadian fauna, seems to have been echoed by researchers and granting agencies in the last 35 years who dismissed these studies as passé.

In another context, how often today do we hear politicians or developers devaluing the need for additional baseline studies or research. It is understandable that political leaders are required to make decisions before answers are available on all issues relating to an environmental problem. It is unacceptable, in my opinion, that the scientific community dismiss the need for baseline, descriptive research to devote availahle monies to more theoretical, leading-edge work.

In studies of biodiversity, the key question is: "What species can be found in our study area?" In the case of birds, which are the most visible faunal group, the presumption would be that this is a summative research problem—in other words we could just look up the answer. A couple of studies conducted by the Provincial Museum of Alberta in two remote regions of northern Alberta (McGillivray and Hastings 1988, 1990) and more importantly the five years of data collecting for Alberta Breeding Bird Atlas project, convinced me of the need for and the value of applied research on bird distributions. The studies showed that in northern Alherta, species such as Mew Gulls (*Larus canus*) and Parasitic Jaegers (*Stercorarius parasiticus*), typical of more northern sites, may be regular breeders or visitors.

The atlas work is producing convincing evidence of shifts in bird distributions, as a result of human activities and anomalies in the distribution of particular species, not apparent in the broad range maps of previous compilations.

What is apparent in summary is two things. First, detailed knowledge of distributions, habitat requirements, and breeding sites for birds in Alberta is still lacking. Second, these relationships are changing and will continue to change thanks to direct human factors such as logging, agriculture, and urban spread and indirectly through climate change or pollution. Tbere is nothing new in this, only the comment that there needs to be a place for applied research that produces species lists and atlas style reports because the data from these studies will always be critical for decision-making.

Pure or more theoretical research is also essential for sound conservation. An area in which we still lack

much knowledge is land management. An oft-stated but overly simplistic view of land management goes like this; "set aside some land, let natural processes work and species will be maintained." The key to biological diversity is habitat preservation. The problem is that we might set aside a piece of land because of what it is today. But in many areas, like the grasslands of southeastern Alberta, if left alone this land will change in response to many factors such as fire, lack of grazing, variations in rainfall, and invasions of woody shrubs. These changes, although natural, may eliminate many of the species or communities that prompted the initial establishment of the reserve. What do we do? As land managers, we might have a particular goal in mind but that goal is rarely compatible with other objectives. Do we accept predator control such as shooting of Coyotes (*Canis latrans*) as the price of successful reintroduction of Swift Fox (*Vulpes velox*)? Do we eliminate grazing to assist Baird's Sparrows (*Ammodramus bairdii*) and thereby reduce habitat for Mountain Plovers (*Charadrius montanus*)? Do we burn sagebrush (*Artemesia* spp.) to replace it with native prairie grass and lose Brewer's Sparrows (*Spizella breweri*) and Sage Thrashers (*Oreoscoptes montanus*)?

Apart from ungulates and waterfowl, we know very little about the specifics of individual species requirements on breeding and wintering grounds. Research is underway now on the effects on bird populations of forest fragmentation in north-central Alberta. This work is critical to development of a sound forest management strategy. Conventional wisdom may be misleading as the work of Charles Kay (1990, Chadde and Kay 1991) shows. Kay has looked critically at "the natural regulation" paradigm adopted by Yellowstone National Park officials as management policy for large ungulates. His work shows that this policy will lead to the extinction of the plant communities on which elk depend. Research by one of my students (Lisa Mahon) on Baird's Sparrows (*Ammodramus bairdii*) at the McIntyre Ranch south of Magrath, Alberta provides another argument against conventional wisdom. The McIntyre Ranch is an area of relatively undisturbed northern fescue grassland. It provides superb habitat for Baird's Sparrows. However, a lack of predators has allowed Richardson's Ground Squirrel (*Spermophilus richardsonii*) numbers to explode. An experiment conducted at the site suggests that opportunistic predation by ground squirrels may be a major source of mortality of Baird's Sparrow nestlings. Hence the superficially attractive site would have to be studied carefully before the Baird's Sparrow population on it could be assumed to be stable.

A final area of research I would like to mention is taxonomic—in my case, species boundaries of passerine birds, particularly in Alberta. Recent work, which my colleagues, students, and myself have been involved with, has shown that there are two distinct species of Warbling Vireo (*Vireo gilvus*) and Solitary Vireo (*Vireo solitarius*) in Alberta. The *gilvus* form of the Warbling Vireo is found in central and southeastern Alberta, whereas the *swainsonii* form is a foothills and northern boreal forest bird. The *solitarius* form of the Solitary Vireo breeds in boreal forest, whereas the *cassinii* form is found in the mountains of the southwest and into the interior of British Columbia. The implications of this are twofold. First, to preserve biodiversity, each member of each pair of species has to be considered separately for possible conservation action. Therefore, the extensive aspen stands in the southern boreal forest may be key to the survival of *Vireo gilvus swainsonii* despite an abundance of *gilvus gilvus* in the aspen parkland. The second implication is: how many more species have populations which may in fact be genetically distinct, even separate species? Even with a well-known group of vertebrates, like birds, there could be many more. With groups such as plants or invertebrates, the list would be huge.

It has been clear from recent studies that many new species (or species new to the region) remain to be discovered in Alberta and undoubtedly elsewhere on the prairies. Before we can conserve anything, we have to know what's there. The research required to identify new species is an essential prelude to effective management or long-term preservation of a species or a habitat.

In summary, research of all kinds; summative, applied, and basic (theoretical), are and will be needed as we encounter problems in maintaining currently protected areas, setting environmental goals, evaluating alternative management plans, and dealing with change. To deny a role for research makes as little sense today as it did to Montague Chamberlain in 1887.

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4. WILDLIFE IN JEOPARDY

PLANT CONSERVATION IN SASKATCHEWAN AND THE RARE PLANTS DATABASE

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THE STATUS OF PLANT CONSERVATION IN SASKATCHEWAN

Traditionally, the protection of rare and endangered native plants has received far less public interest and attention than has that of endangered faunal wildlife, especially birds and mammals. This is even more true for Saskatchewan and western Canada than for more eastern regions, no doubt due in large part to the fewer field botanists here and perhaps a greater general orientation of regional naturalists towards animal wildlife. A botanical component also appears quite lacking in Saskatchewan government departments concerned with wildlife, parks, and the environment. Historically, native flora studies have been given a low priority in terms of research funding.

But in recent years we have witnessed an ever broadening concern for man's stewardship of his whole biological heritage and the preservation of overall natural biological diversity, including the native flora. There now appears to be a better appreciation of the value of conserving whole natural ecosystems (i.e., saving and protecting representative and unique natural areas, with their full species spectra, including the rarest plants and animals in their natural habitats).

It is not sufficient to consider plants as only "habitat" for other "more important" wildlife. Such a narrow view almost invariably ignores the total floristic diversity of natural ecosystems. For instance, overgrazed rangelands, seriously depleted of original species diversity, but "rejuvenated" perhaps to the extent of producing a fair growth of a few food-grasses (native or even exotic), may be considered by some "wildlife" biologists to constitute sufficient "habitat" for particular animal wildlife species, despite its floristically unnatural state. (Perhaps, with tongue-in-cheek, I might suggest that this view is exemplified on page 6 of the Prairie Conservation Action Plan [PCAP], World Wildlife Fund [WWF] 1988), where the textual exhortation that native species need to be conserved in their natural ecosystems, is accompanied by an illustration of a Black-footed Ferret [*Mustela nigripes*] surrounded by its "natural" habitat of exotic Crested Wheat Grass [*Agropyron cristatum*] and Quack Grass [*A. repens*]). But our native flora represents far more than just "habitat." In its total diversity, including the rarest species, it is itself an integral and important component of our total wildlife natural heritage, fully deserving preservation in its own right.

We should never make the error of unequivocally equating "uncultivated" lands to "natural ecosystems," as indeed did the 1988 PCAP and the accompanying WWF map of "Native Prairie in the Habitat Subregions of Prairie Canada." From a botanical point of view, I am convinced that we are actually much worse off in terms of lost natural ecosystem biodiversity, than such "statistics" tend to indicate. It is an unacceptable conjectural "long-jump," to equate unploughed, although often seriously overgrazed and floristically depleted rangelands, to natural prairie ecosystems. In fact, next to the "plough" has been the "cow," in terms of serious agricultural impacts on native prairie plant communities. The natural flora and fauna of never cultivated river and stream valleys may also have been greatly altered by dam-building (with both downstream and upstream effects), water-diversions, channelling, and herbicide runoffs. The latter has also negatively affected many "natural" sloughs, shrublands, and aspen groves. With major and extensive depletions of original ecosystem biodiversity, the rarer species most likely are irretrievably lost. The presumption that disturbed environments are "renewable" through natural successional processes, seems a much over-used and overly optimistic concept (rationale?). Achievement of anything even close to full restorations of the natural species spectra of original flora and fauna, is highly improbable following any serious and extensive disruptions of native ecosystems, whether these are the result of land-cultivation, overpasturing, or forest-clearcutting. It is critical that we preserve significant portions of the few remaining, relatively pristine, native ecosystems before it is too late.

THE SASKATCHEWAN RARE PLANTS DATABASE PROJECT

Although lagging behind research on rare and endangered mammals and birds, work has steadily progressed during the last two decades on delimiting, listing, and recording information about the rarer native plants of Saskatchewan. Historically, in response to an increasing number of inquiries during the 1970s from the interested public, various persons formulated "preliminary lists" of Saskatchewan's rare plants. These earlier, mostly deficient compilations were superseded in 1979 by the publication of the National Museum's Syllogeus No. 20 - "The Rare Vascular Plants of Saskatchewan" (Maher et al. 1979). Subsequently this latter publication has served as the basic reference source on Saskatchewan's rare native vascular plants and their provincial distributions. But after 13 years, this 1979 annotated list of Saskatchewan rare plants is out of date, and was admittedly cursory and tentative from the first. Some included taxa no longer seem to deserve a rarity status because of the additional records now known for them, and others are questionable; a few seem best taxonomically merged under larger groups, while some previously unrecognized rare segregants, appear deserving of separate taxonomic status; and, since 1979, about a score of additional species, mostly deserving a rare status, have been added to the known native flora of the province.

The compilation of actual collection-label data for the locality records, not included by Maher et al. (1979), seemed an important and necessary first step in having enough available information for meaningful evaluations of rarity status and for valid phytogeographical, ecological, and historical interpretations. In response to this need, the "Saskatchewan Rare Plants Database Project" (centred at the Fraser Herbarium, University of Saskatchewan, Saskatoon) was initiated in 1990 and has represented a relatively major information-gathering endeavour, supported by the Saskatchewan Natural History Society and the University of Saskatchewan. The project is basically an attempt to produce a computer-assisted inventory of the collection data and literature reports of Saskatchewan's putatively rare native vascular plants, including their geographical locations, habitats, and population sizes, as well as collection dates, collectors, collection numbers, herbaria where the record-documenting specimens are filed with their accession numbers, indications of identity verifications, and literature references. The candidate list of provincially rare plants included all 300 taxa that were in Maher et al. (1979), plus 175 additional ones, for a total of 475 taxa. The collections from this province of the candidate rare taxa were personally verified and their collection label data recorded, mainly during visitations, thus far, of eight herbaria with sizable holdings of Saskatchewan plants.

The Database "A" includes the recorded localities for each species from herbarium collection labels and literature reports, along with other given data. Although perhaps rearranged to fit the 10 systematized datafields, the transcribed information, for the most part, is precisely that given by the original collector. Whether deemed ample or not, the collector's original label data usually represent the primary or only information available concerning local populations of these species and thus the starting point for the accumulation of more knowledge. The geographical information and coordinates are those given on the original collection labels, with the latitude/longitude coordinates deduced by us being parenthetically included. The recording of actual collection label information and literature reports into the Database "A," which has represented the major and most time-consuming phase of the project, has now been brought essentially up-to-date, (although never completed, but needing continual input of new information). This primary Database "A" has become quite sizable, including a present total of over 8000 collection records, averaging about three duplicate specimens apiece filed in different herbaria. The printouts fill 50 three-ring note-binders.

The second phase of our Saskatchewan Rare Plants Database Project has involved the production of taxon summary sheets, including general information on names, synonyms, herbarium and reference sources of records, general ranges, habitats, previous rarity designations, and assessments of the various facets of each taxon's rarity status in Saskatchewan, such as the number of known localities, distributions of these (regional restrictions), sizes of local populations, etc. This attempted (re)assessment of the provincial rarity status of each candidate taxon has represented our major challenge.

Although for immediate purposes, including the taxon rarity assessments, Saskatchewan distribution maps were hand-prepared for the rare plant candidates, we are instituting a computer Geographic Information System to eventually allow direct transfers of the computerized database information to provincial maps, better permitting various map manipulations and information recoveries for individual and combinations of species as related to geographical areas.

Ultimate goals of the overall Saskatchewan Rare Plants Database project include the production of individual rare taxon summary sheets, an updated list of the provincially rare plants in Saskatchewan with an assessment of their rarity status, and a priority-categorized list. Our database of herbarium specimen data and literature reports is only a first step in compiling knowledge about our provincial rarities. Almost all rare species require further field and laboratory studies, followed by efforts to conserve them in their natural habitats. The nationally rare species represent immediate candidates for the production of detailed, full-fledged, COSEWIC (Committee on the Status of Endangered Wildlife in Canada) status reports on their rarity status.

With the available information on our rare species continually increasing, their rarity status remains in a dynamic state, needing continuous reevaluation. Any new locality and collection data on Saskatchewan rare plants should be forwarded to the Fraser Herbarium, University of Saskatchewan, Saskatoon, for verification and entry into the Saskatchewan Rare Plants Database.

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MONITORING RARE PLANTS - MORE THAN JUST LOOKING FOR A FOUR-LEAVED CLOVER

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INTRODUCTION

In this paper, we introduce and summarize approaches to rare vascular plant monitoring and then review some of the monitoring projects being done in Alberta.

What is rare plant monitoring? Palmer (1986) defined it as "the acquisition of quantitative data that documents the condition of the population or community over time." First, a population or species of concern is identified—it may be rare, endangered, or even just locally threatened or uncommon. Then, a monitoring program is developed.

TYPES OF RARE PLANT MONITORING

There are three main types of monitoring generally recognized (Palmer 1986): 1) simple count or estimate of individuals (inventory); 2) comprehensive appraisal of part of a population, usually using plots or complete counts (census); and 3) using permanent plots to gather data on growth, mortality, and reproductive capability of individuals (demographic monitoring).

Inventories and censusing can result in an indication of population trends; censusing and demographic monitoring can give insight as to why these trends are occurring. The following discussion looks at each type in more detail.

Inventory

Initially, a population must be inventoried to collect baseline data. The number of individuals is counted or estimated using a repeatable method. This is an important first step in determining the status of the species of concern.

Often, as part of the count, the numbers of seedlings, as well as numbers of flowering, non-flowering, fruiting, and senescent individuals are noted or estimated. Individuals may be grouped according to size and age classes and the numbers in each class noted. It is important to clearly define the classes so that subsequent surveys can yield comparable results. Additional information that should be noted in an inventory type of monitoring program (Henifin et al. 1981) includes the following: the exact location of each population, with clear directions to allow easy relocation; detailed habitat descriptions for each population; the extent of the area that the population covers, noting any areas or microhabitats that appear important to the population; any observations on species biology such as the identity of pollinators or nature of seed dispersal mechanisms; and any evidence of disturbance, impacts, predation, or threats.

Repeating an inventory over a number of years is the simplest form of monitoring. This can indicate the vigor, over time, of a specific population. Such monitoring can also reveal whether the population is stable, increasing or decreasing.

Census

The census type of monitoring is usually more complex than, but can be very similar to, the inventory type. Permanent plots are set up and individuals are counted (or estimated using a repeatable method) within the plots. Depending on study objectives, plots may be set up in different habitat types, or in habitat types that are comparable but under different management regimes. The populations can be counted and compared. The census type of monitoring is useful for determining preferred habitats and those factors limiting the population, or for evaluating effects of different land uses (e.g., grazing, haying, and recreation use).

Demographic Monitoring

Demographic monitoring programs are studies that follow the fate of individual plants. Usually individual stems are marked and/or mapped in a population and followed through the growing season, often for several years. This type of monitoring program is complicated

and time-consuming and, therefore, is not appropriate for all species. Demographic monitoring is used mainly for species or populations for which detailed information about life history may be required to ensure survival.

Demographic monitoring gathers information on distribution, ecology, predation, mortality, and reproduction. As with a census program, the population size and numbers of flowering individuals are determined. In addition, the following characteristics may be studied: fruit and seed set, plant height, leaf number, leaf size, stem diameter, seedling number, distribution, predation, and mortality.

A demographic monitoring program can be quite complicated, measuring every population characteristic possible, and making comparisons in several different habitats, or it can be quite simple, measuring only one or two factors. Which factors are important will depend on the species being monitored. Owen and Rosentreter (1992) looked at several of the possible approaches and factors, and discussed some of their advantages and shortcomings.

SETTING UP A RARE PLANT MONITORING PROJECT

The goal of a monitoring program is to "provide data that can be used to maintain, enhance and ensure the survival of the population, the species, or the natural community to which they belong" (Sutter 1986).

For a monitoring program to provide relevant, useful data, it must be carefully tailored to the species being monitored, designed to answer specific questions, and characterized by enough flexibility to allow change. Before a monitoring program is set up, as much information as possible should be compiled from the literature on the species of interest, including: population biology, environmental requirements and preferences, pollinators, parasites, diseases, seed predation, herbivory, demography, community structure, etc. (Baskin and Baskin 1986). One of the objectives of a monitoring project is to try to fill information gaps.

Pickart (1991) suggests six steps to set up a monitoring project: 1) review available information; 2) collect and determine the adequacy of baseline data; 3) identify research needs; 4) establish objectives; 5) determine variables to monitor; and 6) develop field methodology.

This process was designed to ensure that the monitoring program is tailored to the species to be monitored and to assist in the selection of important and appropriate factors to monitor.

IDENTIFYING ALBERTA SPECIES OF CONCERN

Although lists of rare species for Alberta have been available for years (Argus and White 1978, Packer and Bradley 1984), very little information has been available on the status of individual species. Since about 1986, interest groups and government agencies have been working together, first to determine the priority species and their Alberta status, and then to begin to monitor some species.

Defining Priority Species

The first step in identifying priority species was a detailed literature search on each of the 360 species included on the list of rare plants for Alberta (Packer and Bradley 1984). The purpose of this project was to look at the status of each species throughout its range in order to develop priorities for further species studies (Fairbarns et al. 1987, Cottonwood Consultants Ltd. 1987, Wallis et al. 1987a and 1987b). Generally, endemic species were considered highest priority, then disjunct species, then peripheral species. This was the first step in compiling the information required to assess and manage range plants in Alberta. The next phase was to locate and inventory populations of rare species, concentrating on those of highest priority.

A rare plant is defined here as a species with a small population within the province. A threatened plant is a species likely to become endangered in all, or a significant part of, its range in the province, if the factors affecting its vulnerability do not become reversed. An endangered plant is a species in danger of extirpation through all, or a significant portion of, its range in the province.

Of the 58 species that have been reviewed (Cottonwood Consultants Ltd. 1986 and 1988a), six species are considered endangered in Alberta: Onion (*Allium geyeri*), Mountain Lady's-slipper (*Cypripedium montanum*), Yellow Indian Paint-brush (*Castilleja cusickii*), Sand Nut-grass (*Cyperus schweinitzii*), Blue Flag (*Iris missouriensis*), and Western Spiderwort (*Tradescantia occidentalis*).

The following six species were determined to be threatened in Alberta: Sand Verbena (*Abronia micrantha*), Low Milk Vetch (*Astragalus lotiflorus*), Nebraska Sedge (*Carex nebraskensis*), Goosefoot (*Chenopodium subglabrum*), Annual Skeleton-weed (*Lygodesmia rostrata*), and Clammyweed (*Polanisia dodecandra*).

Eight species were recommended for deletion from the rare species list, and the remaining 38 species were determined to be rare in Alberta.

The gathering of detailed background information has been initiated or completed for some of the endangered species (e.g., Wilkinson 1987).

When faced with almost one-quarter of the provincial flora being listed as "rare," it is difficult to know where to start to monitor and protect species and habitats. Using a process of sifting through the full list of rare species to identify priority species and then determining the status of priority species, the task has been made much simpler.

Since 1986, when priority species were initially identified, the Rare Vascular Plants in Canada (Argus and Pryor 1990) has been published. This document ranks species on a national level, thereby providing further information for identifying priority species to monitor.

MONITORING PROJECTS IN ALBERTA

Three examples of monitoring projects are presented here: the endangered Blue Flag; a single population of Yellow Indian Paint-brush, which is also considered endangered; and two rare species, Smooth Boisduvalia (*Boisduvalia glabella*) and Upland Evening Primrose (*Oenothera andina*). Although these are also priority species, a main focus of the last two monitoring projects is to examine the effects of grazing management strategies on these rare species, and to guide changes in management practices as required.

Western Blue Flag Monitoring in Southwestern Alberta

Because this species was found to be endangered in Alberta and occurs nowhere else in Canada, Western Blue Flag clearly has a high priority for conservation in Alberta. Argus and Pryor (1990) gave Western Blue Flag their highest priority rating (priority 1).

A census of known Blue Flag populations was undertaken in 1987 and permanent monitoring plots set up. The objective of this monitoring project is to track the status of this endangered species and to determine population trends (Cottonwood Consultants 1988b).

Plots were set up to sample a cross section of populations in slightly different topographic positions, populations under different grazing regimes, and populations in the main concentration areas. By placing plots in a variety of habitats and management regimes, information on the preferred habitat and on effects of management is being gathered. Six plots (2.5 m x 2.5 m) were set up to include the maximum number of individuals. Corners were permanently marked with metal tubing and measurements to other features were taken to aid in plot relocation.

Each plot was overlain by a grid of 100 squares (250 mm by 250 mm), using nails and twine. The Blue Flag stems in each square were counted and recorded as flowering and nonflowering. Each plot was photographed and habitat features, such as shrub growth and topography, were noted. Each site was revisited in August to determine seed set and vegetative changes. The populations need to be inspected yearly and censused every third year (Cottonwood Consultants 1988b).

Yellow Indian Paint-brush Monitoring at Outpost Wetlands Natural Area

The Outpost Wetlands Natural Area was purchased in 1987 by Alberta Forestry, Lands and Wildlife and the Nature Conservancy of Canada. Heavy grazing and conversion to non-native pasture had severely degraded the "naturalness" of the site, but with its diversity and extensive wetlands, the site was still considered a valuable contribution to the protection of Alberta's natural diversity.

The Outpost Wetlands Natural Area is located in southwestern Alberta in a region known as one of the four richest areas for rare plants in Alberta (Cottonwood Consultants Ltd. 1983). Accordingly, eight rare species were documented during the rare plant inventory (Cottonwood Consultants Ltd. 1989a). Of these, one was Yellow Indian Paint-brush, a species that

previous inventory studies had determined to be endangered in Alberta (priority 2) and a high priority for protection (Argus and Pryor 1990).

In Alberta, Yellow Indian Paint-brush is peripheral—at the northern limit of its range. Found in moist meadows and grasslands, this species of limited distribution seems to occur only in small populations (Wallis et al. 1987a). Such wet meadows are usually associated with groundwater flow near the surface. This type of habitat is uncommon in Alberta and has been extensively affected by activities such as grazing, cultivation, and introduction of non-native species (Cottonwood Consultants Ltd. 1986).

Cottonwood Consultants Ltd. (1986, 1989a) suggested that the species requires ungrazed or lightly grazed lands, and does not compete well with introduced grasses such as Timothy (*Phleum pratense*) and brome (*Bromus* spp.). Since the purchase of the Natural Area in 1987, the site has been essentially ungrazed. However, even though an absence of grazing should be beneficial to the paintbrush, brome and Timothy appear to be encroaching on the population. If the grazing served to keep these introduced grasses in check, the removal of grazing may prove to be, in fact, harmful to the population in the long-term.

Because of the endangered status of the species and the population in the Natural Area is small, a yearly census type of monitoring project was initiated. The purpose of this project is to document the status of the population over time and to recommend additional monitoring or management, if necessary.

The initial visit to set up the monitoring project was timed to coincide with Yellow Indian Paint-brush flowering, because this would be when individual plants would be easiest to spot. Each Yellow Indian Paint-brush stem was measured and mapped, and general observations made. The number of stems had increased from three, as first noted in the 1989 inventory, to four in 1990.

The researchers took several hours to relocate the population because of the small size of the population and the inconspicuous nature of the species, even though the location of the population was mapped during the initial inventory. To ensure that such delay would not be a problem for subsequent researchers two pins were located and compass bearings determined from prominent landmarks. From the second pin, the compass bearing and distance to the population was determined. This second pin was located within 5 m, far enough to avoid any trampling of the population, but close enough to ensure the population could be relocated.

In 1991, the visit to the Natural Area was scheduled as part of a larger field project. Unfortunately, the timetable had to be set up well in advance. The 1991 season in southwestern Alberta was at least two weeks delayed because of unusually cold weather and greater than normal rainfall. When the Outpost Wetlands Natural Area was visited, the pins were relocated, but the population of Yellow Indian Paint-brush could not be found. Because of the preset schedules, it was not possible to revisit the site in 1991 within the paintbrush flowering season.

Although the inability to relocate the population was somewhat discouraging, it did provide some interesting lessons in plant monitoring. If the monitoring program had been conducted only in 1989 and 1990, we would have concluded that the population was doing relatively well. If the monitoring had been scheduled for every second year, since it was found in 1989 but not in 1991, we might have concluded that the population had been extirpated. Clearly, either conclusion would be premature.

The preceding example reinforces the points that a plant monitoring program must be done over several years, and must remain as flexible as possible to ensure that the populations being monitored are visited at the most appropriate time.

A method of accurately relocating the plant, especially for extremely small populations of inconspicuous species, is essential. Without being confident of searching in almost precisely the right area, the researchers can waste numerous hours (we spent over one hour searching in 1991, even with marker pins and a map) searching for a population that cannot be detected at that specific time.

Where were the paintbrushes in 1991? Were they gone? Were they there, but not distinguishable from the meadow's dense herb and grass? Perhaps they had not yet emerged, because of the cold, wet, and late season. Only by carefully scheduling the 1992 visit will we know.

Milk River Natural Area and Kennedy Coulee Ecological Reserve

At these reserves a census type of monitoring, provides a comprehensive appraisal of part of a plant population in southern Alberta. These protected areas are being managed as a single unit to protect and maintain the ecological and aesthetic character of a representative example of the Mixed Grassland Natural Region, with miuimal human interference.

The general management philosophy is to ensure the perpetuation of a variety of representative habitats. The areas have been ungrazed for the past two decades and, thus, offers a good opportunity to study the effects of grazing on the grassland structure in this part of Alberta. The ecological reserve will continue to provide ungrazed conditions and will serve as a control area. In the natural area, the vicinity of dugouts and salt blocks will be heavily grazed, thereby providing habitat for those species that rely on areas of very short grass (e.g., Mountain Plover [*Charadrius montanus*]). The remainder of the uplands will be grazed, initially at a low stocking rate, to provide lightly grazed habitats. A monitoring program, including a component that considers rare vascular plants, was implemented in 1991, before the entry of cattle. The results of the program will be used to guide management strategies for the site and provide advice to grazing managers elsewhere.

Seventeen species of rare vascular plants, as defined by Packer and Bradley (1984), are known from the Milk River Natural Area and Kennedy Coulee Ecological Reserve. Monitoring efforts focus on two species at present—Upland Evening Primrose and Smooth Boisduvalia—both of which are considered to be rare in Canada (Argus and Pryor 1990). These species were chosen because: they have a high Canadian priority (3) for protection (Argus and Pryor 1990); they are thought to be intolerant of heavy grazing (Cottonwood Consultants Ltd. 1989b); and they occur within the area being managed and therefore, may be affected.

Upland Evening Primrose, a member of the evening primrose family, is a small annual that ranges from southern British Columbia, southeastern Alberta, southwestern Saskatchewan, south to California, Utah, and Wyoming (Moss 1983). Its specific habitat requirements comprise somewhat exposed, sandy soils in moist swales or hillsides (Cottonwood Consultants Ltd. 1989b).

In the study area, Upland Evening Primrose has been found in two locations (Cottonwood Consultants Ltd. 1989b), only one of which is the site of census work. Nonetheless, counts were made of the number of individuals found in both populations. A permanent marker pin was placed in the approximate centre of the census population to facilitate finding it in the future. The couuting of individuals was carried out when the plants were in flower (i.e., early June). All subsequent counts will be repeated when the plants are at the same stage.

Measurements were completed before the entry of cattle onto the site, so that baseline information was obtained on the size of the population before grazing. We will be doing annual counts of individuals for at least the next three to five years. If we find that the use of cattle is adversely affecting the population, we will alter our management approach, either by lowering the carrying capacity or drawing the cattle away from the site by positioning of fences or salt blocks.

The second species that we looked at, Smooth Boisduvalia, is another member of the evening primrose family. It is also restricted to the southeastern portion of the province, is found on dry mud flats, and is thought to be intolerant of grazing (Cottonwood Consultants Ltd. 1989b). The boisduvalia is found at one location in the study site, along an intermittent stream. The same methodology was followed as for the Upland Evening Primrose, though the counts were carried out in August (when the plants were flowering), and by that time cattle were already on site.

It is too early to draw any conclusions from monitoring efforts at Milk River, because the purpose of this past year's work was to collect baseline data.

Future Monitoring

Plans for future monitoring at Milk River include expanding the program to include other species of rare vascular plants. The same selection criteria will be used as in the preceding cases. These additional species will have a relatively high priority for protection according to Argus and Pryor (1990), will be considered intolerant of grazing, and will occur within the area being grazed by cattle. We may also expand the program to include more detailed demographic work

on the populations now being monitored, especially if we find that they are being adversely affected by management practices.

The rare plant monitoring project is only one component of a larger monitoring program that is examining the effect of management on the ecosystem. It is, however, an important component. The results of one part of the monitoring program (e.g., rare plants) will not be viewed in isolation but in conjunction with the other monitoring projects before we adjust any management strategies. Monitoring of rare plants can be an inexpensive program to implement and follow up. At Milk River, we are fortunate to have volunteers who are keen to help out. Clearly, in areas where one is attempting to manage an ecosystem, monitoring of rare plant species should be a component of any monitoring program. After all, plants are wildlife too.

CONCLUSION

If maintaining natural diversity is one of our goals as conservationists or land managers, monitoring of at least the most vulnerable species is needed to ensure that goal is met.

Habitat loss is often the main threat to a species. But, even if the habitat of a species of concern has been secured, this may not always be enough to ensure survival of the species. If there have been changes to an area, or if disturbances or other factors are suspected of causing a decline, monitoring is important to verify population trends. A well-planned monitoring program may also help to understand why the population numbers are changing.

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DEVELOPING A CONSERVATION AND MANAGEMENT STRATEGY FOR RIPARIAN FORESTS IN SOUTHERN ALBERTA

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INTRODUCTION

Riparian forests are the hidden ecosystems of the prairies. Tucked away in river valleys, they are seldom included when we conjure up a vision of prairie. However, many inhabitants of the prairies find their lives enriched immensely by native riparian forests. These prairie ecosystems, although very limited in area, have, and with appropriate care, will continue to sustain a disproportionately large amount of prairie life ecologically, culturally, and spiritually.

Riparian habitats (rivers, streams, and their edges) were specifically recognized in the Prairie Conservation Action Plan (World Wildlife Fund [WWF] 1988). To quote under Goal 3: "...native prairie reserves should be connected by habitat corridors such as riparian habitats.... Riparian habitats are extremely productive systems. Due to water and land management practices, they have become some of the most threatened ecosystems in arid and semi-arid regions of the world.... Action: Within the next five years, habitat management plans for riparian ecosystems should be developed."

In the spring of 1990, Prairie for Tomorrow (a joint program of WWF and the Alberta Fish and Wildlife [AFW] Division) initiated development of a strategy for conserving and managing riparian poplars in southern Alberta. "Riparian poplars" translates into "riparian forests" throughout the central and western Great Plains of North America, since poplars, or "cottonwoods," are by far the predominate native tree species. Western Environmental and Social Trends (WEST) (1991) was contracted to conduct the consultations.

PROCESS

In the environmental management projects it undertakes, WEST applies two fundamental principles. The first principle is that decisions about environmental management must be based on the best available information—information which is current and factual. The second is that all points of view need to be examined in a neutral atmosphere and opportunities provided for achieving consensus and resolving any disputes through open discussion.

To help develop the strategy, an Advisory Group was established with representatives from Alberta Cattle Commission, Alberta Environment, AFW, Federation of Alberta Naturalists, Regional Coordination Services of Alberta Forestry, Lands and Wildlife, the Water Resources Commission, and WWF Canada. The Advisory Group was responsible for providing advice on the consultation process and reviewing and commenting on information materials developed.

Strategy Development has Occurred in Four Steps

Step One: Biology and Status Report

A study was carried out during June to December 1990 to determine the present distribution and density of poplars along rivers in southern Alberta and to assess changes in distribution and density using aerial photography and historical maps. As well, a review of studies relevant to the conservation biology of riparian poplars was undertaken. To ensure accuracy and completeness of the review, a draft was circulated for comment to several knowledgeable scientists. The revised report, *"The Biology and Status of Riparian Poplars in Southern Alberta"* was published in February, 1991 and about 200 copies distributed. It provides managers of riparian habitats and other interested individuals with an information base to assist in decisions about conserving and managing riparian poplars.

Step Two: Interviews with Stakeholders

The second step in developing a strategy was to determine the scope of conservation and management issues and the options available for dealing with these. As a means of ensuring input from those individuals who have an interest and a role to play in the management of riparian forests, interviews were conducted with 46 key stakeholders during April through June 1991. Interviewees included resource planners, water managers, public lands managers, wildlife specialists, natives, irrigation water users, conservationists, canoeists, researchers, and ranchers. Results of the interviews are

summarized in a report *"Results of Interviews with Key Stakeholders"* published in August 1991. This report was provided to all interviewees, to the Assistant Deputy Ministers of appropriate agencies, and to members of the Prairie Conservation Coordinating Committee (PCCC). The PCCC is a 50 member multi-stakeholder committee charged with implementing the Prairie Conservation Action Plan in Alberta.

Step Three: Draft Strategy and Strategy Workshop

A workshop to discuss and recommend a strategy for conserving and managing riparian poplar forests was held in conjunction with a meeting of the PCCC on January 28, 1992. Forty individuals from a broad range of government and nongovernment stakeholder organizations participated in the workshop. Discussion at the workshop focused on a draft strategy that had been developed based on the Biology and Status Report and the Stakeholder Interviews and on further information collected, including an assessment of ownership of lands supporting riparian forests.

Step Four: Recommended Strategy

The Recommended Strategy is based on the findings, conclusions, and recommendations of the Biology and Status Report, the Stakeholder Interviews, and the Strategy Workshop. It encourages a pro-active plan of action for conserving and managing riparian poplar forests which will involve not only government agencies, but also organizations and individuals outside of government. The Recommended Strategy will be provided to all workshop participants and presented to the PCCC, the Water Resources Commission, and the Assistant Deputy Ministers of Natural Resource Agencies for their review and hopefully endorsement.

DISTRIBUTION AND STATUS

Riparian forests are found along about 1500 km of river in southern Alberta. They occupy about 700 km^2, or less than 1% of the grassland region. Of the 2075 km of river valley in southern Alberta 9% supports very dense stands of trees, 15% supports dense stands, 22% supports moderate stands, 30% supports sparse stands, and 23% has no forests.

River reaches supporting moderate to dense stands have broad floodplains (greater than 500 m) and channels which are freely meandering or braided.

Distribution and density of mature forests appears to have changed little since the 1950s, based on a comparison of 1980s air photos with those for the 1950s. Slight increases have occurred along three 50 km reaches on the South Saskatchewan, Red Deer, and Bow Rivers.

Significant declines have occurred along the St. Mary and Waterton Rivers below dams, and along a 10 km reach of the Milk River due to fire. As well, recent studies on the Red Deer, Oldman, and Willow Creek suggest that regeneration and survival of young poplars is not adequate to replace, in areal extent, the mature canopy. Lack of regeneration and decline in mature forests also have been documented along rivers in Montana, North Dakota, Wyoming, Colorado, Arizona, and California (Bradley et al. 1991). Factors identified as contributing to lack of regeneration and survival are: altered flows and sedimentation processes due to dams and diversions, livestock grazing, floodplain developments, herbicide use, fire, Beaver (*Castor canadensis*), and prolonged climatic drought (1930s).

Ownership of riparian forests in southern Alberta is as follows: private - 47.7%, provincial (excluding parks) - 21.8%, Indian reserve - 17.6%, town/city - 4.3%, unknown - 3.7%, park/natural area - 2.8%, federal - 1.6%, and municipal district/county - 0.4%.

BENEFITS OF RIPARIAN FORESTS

Benefits and Values of Riparian Forests Identified by Interviewees

Recreation

For many southern Albertans, riparian forests are preferred above any other prairie environment for outdoor recreation activities including picnicking, hiking, bicycling, and camping, and they contribute immeasurably to water related activities such as fishing and canoeing. Seven provincial parks as well as major urban parks and trail systems and several parks in smaller centres are located in riparian forests. These forests also are the sites of several provincial recreation areas and roadside picnic points. Popular boating trips are on reaches bordered by poplar forests.

Wildlife Habitat

Wildlife surveys have found deer concentrate in southern Alberta riparian forests during breeding season and critical winter periods with densities of about 12 per square kilometre recorded in one winter survey,

far exceeding those of any other prairie habitat. As well a study in poplar forests of Dinosaur Provincial Park found that breeding bird densities are among the highest in Canada (550 to 706 pairs per 40 ha) and that about 70% of the bird species ou the prairies use that habitat exclusively (Bradley et al. 1991).

Aesthetics

Poplar forests in river valleys are considered by southern Albertans to be an important part of the prairie landscape. They provide scenic relief and diversity. Even individuals who seldom go into these forests value them for aesthetic reasons.

Livestock Shelter

For livestock producers on river valley lands supporting poplars, these woodlands provide their animals shelter from sun aud wind.

Water Quality

Riparian forests can improve aquatic ecosystems by stabilizing banks, contributing organic matter, providing shade and regulating runoff. On the other hand they may take water from the river through evapotranspiration.

Intrinsic, Spiritual, and Cultural

Some southern Albertans derive spiritual value from riparian forests while others recognize intrinsic or existence values. Furthermore, poplars play an important role in some native ceremonies and traditions where they are recognized as having their own spirits. In the past, riparian forests served as winter camps for the Plains Blackfoot. As well, early settlers built their homes in the shelter of poplars. The distribution of these forests was a factor in the location of Indian reserves and other settlements in southern Alberta.

PROBLEMS AND CHALLENGES

Before effective solutions can be devised, problems need to be clearly defined. Experience in Alberta and other jurisdictions shows that loss of riparian forests on the prairies can occur if their requirements are not considered in water and land use planning and management. If the benefits that riparian forests provide are to be assured, Albertans will need to recognize a responsibility for conserving these forests and develop an understanding of how their activities affect them (Bradley et al. 1991).

Key challenges in developing a management strategy for riparian forests are as follows:

1. Information gaps and scientific uncertainty need to be addressed for improved decision-making.

2. Implementing a management strategy for riparian poplars will require that southern Albertans understand the issues and are willing to make the necessary changes.

3. A fuller accounting of costs and benefits is needed when making decisions about water management and floodplain developments that will affect riparian poplars.

4. A comprehensive approach to managing riparian poplars requires that land management and water management decisions be integrated.

5. Areas of riparian poplars with particularly significant ecological, recreational, or cultural values and which are considered threatened need to be addressed as a priority.

RECOMMENDED STRATEGY

The Recommended Strategy is designed to address the challenges identified through the stakeholder interviews. At the multi-stakeholder workshop, participants agreed on a vision, mission, and guiding principles for the strategy.

The vision of Albertans for riparian poplars is that: Native riparian forests will flourish along southern Alberta rivers so that current and future generations of Albertans can enjoy their benefits and appreciate their intrinsic value.

The vision is fundamental to the development of a mission statement. The mission of a strategy for managing riparian poplars in southern Alberta is: To sustain native riparian forests as key components of southern Alberta river ecosystems by managing land, water, and resource use to protect ecological integrity.

The strategy is built on commonly accepted principles. These principles, which reflect beliefs and values, were enunciated in various ways by Albertans during development of the strategy. They are presented here in no particular order of priority:

1. Best available scientific and technical information should form the basis of riparian forest management decisions.

2. There should be public access to accurate and credible information to assist in making informed decisions about the management of riparian forests.

3. Cooperative and consultative approaches to decision-making and action are essential.

4. Full consideration of environmental, social, and economic costs and benefits should be a part of decision-making.

5. Innovation and flexibility in achieving goals and actions is important. The most desirable solutions are those which are not only ecologically sound, but also cost-effective.

The following five goals are designed to address the problems, opportunities, and key challenges identified for the Riparian Poplar Management Strategy. They are based on the agreed upon principles already outlined. In the Strategy Report each goal has been translated into specific objectives and actions, however these will not be presented in detail here.

1. Goal A: Improve awareness and communication about native riparian forests—their benefits, ecology, management issues, and actions needed to perpetuate these benefits. The objectives and actions address development of awareness programs which consider appropriate information, providers of information, delivery infrastructure, and audiences (landholders, resource managers, stakeholders from agricultural, environmental and recreational groups, and the general public).

2. Goal B: Improve water planning and management for the conservation of riparian forests. The objectives and actions address consideration of riparian forests in instream flow needs studies; operating plans for current and proposed dams and diversions; and environmental assessments on proposed water management projects.

3. Goal C: Improve public and private land use planning and management for the conservation of riparian forests. The objectives and actions address recognition of riparian poplars in provincial, municipal, and other land use plans; a pilot project for achieving conservation of an Environmentally Significant Area (ESA); environmental assessments on floodplain developments; and landholder recognition and incentives. (Note: An ESA is a natural area which has been identified as requiring special environmental management in ESA studies conducted for individual counties and municipal districts in southern Alberta.)

4. Goal D: Identify and remedy information gaps regarding native riparian forests, for improved decision-making. The objectives and actions address research on flow and sedimentation needs, grazing effects, beaver effects, reclamation, and values.

5. Goal E: Implement a comprehensive approach to managing riparian ecosystems which integrates land and water management decisions. Objectives and actions address development of an integrated approach or management system for riparian ecosystems and monitoring results.

The strategy has been developed to assist various government and nongovernment organizations in conserving and managing riparian forests in southern Alberta. It's success will depend on individuals and organizations accepting responsibility for actively managing to protect riparian ecosystems and basing their management decisions on the strategy. Copies of the *Strategy for Conserving and Managing Riparian Forests* can be obtained from Alberta Forestry, Lands and Wildlife, Information Centres in Edmonton and Calgary.

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AMPHIBIANS IN MANITOBA

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ABSTRACT

Fifteen indigenous species of amphibians are known to breed in Manitoba. The Leopard Frog (*Rana pipiens*) has been the most commercially valuable. A fall amphibian season was established in 1971 and up to 50,000 kg of Leopard Frogs were shipped out of the province annually in the early 1970s. Leopard Frog populations died out in 1975/1976, with only a few population pockets remaining. No mortality cause was identified and recovery has been slow, especially in what were once the main population centres. Recent global concern for amphibian populations and local field reports of declines in calling frogs have encouraged the establishment of an annual frog monitoring system in the province. There is also support for detailed studies on amphibian species and their habitats here.

MANITOBA'S RICHNESS

Manitoba contains 15 known species of native amphibians. Ranges and basic information is contained in Bill Preston's (1982) book Amphibians and Reptiles of Manitoba. The most abundant and widespread species are the Wood Frog (*Rana sylvatica*), Leopard Frog, Boreal Chorus Frog (*Pseudacris triseriata maculata*), and Dakota Toad (*Bufo hemiophrys*). Of most significant economic importance is the Leopard Frog which finds excellent habitat in the large shallow lakes with associated marshes in Manitoba.

COMMERCIAL ACTIVITIES

Manitoba Leopard Frogs were larger (9-12/pound) and more hardy (held live until spring term) than were frogs from other commercially harvested areas. Therefore, the province traditionally dominated a large portion of the North American Leopard Frog marketplace, with suppliers paying local collectors approximately $6/kg; and shipping as much as 50,000 kg of frogs to United States Biological Supply Houses.

Prior to 1971, there was frog harvesting both in the fall and winter. In the fall, after "hardening in," they were caught at night along the shores of Lake Manitoba, by hand, with the aid of miner's lights. In the winter, the frogs were captured near Chatfield in artesian wells with long-handled nets and stored in 45 gallon barrels. In 1971, Manitoba established amphibian and reptile seasons.

The amphibian season ran from August through October and the reptile season (Red-sided Garter Snakes [*Thamnophis sirtalis parietalis*]) initially ran the month of September. Much of the frog picking after 1971 was tied to the snake season, since many of the buyers bought both snakes and frogs and pickers typically hunted both species. Pressures of having to pick a maximum number of frogs within a lesser time frame led frog pickers to disobey the seasonal laws creating hostility amongst themselves since each dealer had a maximum number of snakes and frogs to purchase, and once these quotas were reached, no more frogs or snakes were purchased. Once the buyer's quotas were reached, it was not uncommon for additional frogs to be dumped and considered waste.

THE LEOPARD FROG DIE-OFF

The Leopard Frog die-off began in Europe in the late 1950s, reaching North America by the late 1960s, then spreading south and north. Dr. Ken Stewart, at the University of Manitoba, anticipated the die-offs, monitored populations and did laboratory analysis of sick and dying frogs. He had students working with frog populations in the Delta Marsh while his lab work included monitoring over a dozen possible factors involved in the die-off. The University of Wisconsin in Madison also monitored frog populations and attempted to determine possible causes for die-offs. Neither the Wisconsin or Manitoba study pinpointed the cause of death when it occurred. The typical reason given for death was "red leg," a term used to describe a condition in which blood vessels broke down and body fluids accumulated in the semi-transparent tissues on the underside of the hind legs. This condition is a symptom of tissue breakdown and kidney failure but is not a disease in itself.

Leopard Frogs began dying off in Manitoba in 1975, and by 1976 were virtually gone from major population centres. Windrows of dead and dying frogs were

Table 1. Manitoba's reptile and amphibian harvest; from dealer records.

Year	Frogs (pounds)	Snakes (number)	Salamanders (pounds)
1971	68,348	24,800	no record
1972	109,796	56,465	no record
1973	26,272	68,621	no record
1974	43,868	63,429	no record
1975	12,980	30,370	no record
1976	0	48,142	no record
1977	0	34,745	no record
1978	0	43,667	no record
1979	0	23,220	no record
1980	0	30,000	no record
1981	0	37,409	no record
1982	0	64,992	no record
1983	2,911	43,440	no record
1984	13,058	57,245	no record
1985	30,162	90,080	no record
1986	35,981	71,569	no record
1987	9,079	68,497	no record
1988	2,516	82,268	no record
1989	3,546	no season	90
1990	5,891	no season	no record
1991			no season

Records are minimal as sales go unrecorded annually.

reported on Lake Manitoba shorelines, while piles nearly a metre high were recorded from artesian wells. The die-offs were most complete where frog populations were most dense. Some Leopard Frogs survived in isolated populations (golf courses, stock ponds, islands) but the die-off resulted in no frogs being marketed from Manitoba, 1976 to 1983 (Table 1); despite excellent market conditions.

RECENT EVENTS

Following the population crash in 1975/1976, isolated populations remained and in 1983 they were again commercially harvested. Leopard Frog populations have recovered in some areas but densities are not near their former levels. They have not re-occupied the frog holes and appear to be slowly re-building populations in what were their major Manitoba habitats. A site just west of Winnipeg along the Assiniboine River contained all three color variations of the Leopard Frog (blue, green, and brown spots) in the fall of 1990.

Recent increases in Leopard Frog populations in the United States and Mexico and captive rearing facilities have depressed the frog market. The animal rights movement, and increased computer use in education, have brought about a decrease in the demand for Leopard Frogs. Frog prices were lower in 1990/1991 than they had been in the early 1970s, reducing the value of sales records for population estimates.

CAUSE AND EFFECT OF DIE-OFFS

When searching for a cause, we must look at the available factors. Leopard Frogs died off throughout Europe and North America yet no one disease or parasite has been identified as responsible. That fact makes us consider environmental stress factors which may have been severe enough to allow normally benign factors to suddenly combine to kill off populations throughout entire habitat ranges. Since frogs breath through their skin, they are extremely vulnerable to air or water born pollutant stress. The massive Leopard Frog die-offs that occurred without an identifiable cause should have generated extreme concern for the human environment, since amphibian populations are excellent indicators of our world environment. Amphibian population monitoring is needed across Canada and I commend the organizers of this workshop for including this class of species.

AMPHIBIAN SURVEYS FOR MANITOBA

Millions of dollars are being spent world-wide to study amphibian populations. Most to determine if recent population declines are part of a long-term cycle or the result of global changes. If amphibian declines are resulting from man influenced changes in the environment, then society had better know the factors involved so that changes can be made before the planet becomes unsuitable for human life. The following are a few ways in which data could be easily collected on not only Leopard Frogs, but all frog species in Manitoba.

1. Owl surveys are expected to take place annually in southeast Manitoba. Volunteers stop each ½ km to play owl tapes and record calling owls. This survey could easily include recording frog calls if survey members were provided with frog calling tapes and data sheets. Only four to six species would be recorded at that time of year but population trends could be determined for those species.

2. Road surveys are done for breeding birds throughout much of Manitoba. Frog calls could be recorded at each survey stop when volunteers returned to their starting locations. Only a few species would be calling at that time of year but population trends could be determined for them over time.

3. Several Manitoba naturalists spend much of their time in the field, viewing, recording, photographing, and searching for birds and other wildlife throughout the province. These people could be encouraged to record frog calls, egg masses, and tadpoles, especially if they were provided the appropriate tools to identify the species involved and data forms on which to record the information.

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MONITORING AMPHIBIAN POPULATIONS IN ALBERTA: ARE THEY DECLINING?

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Alberta can be divided into four biotic provinces (prairie, aspen parkland, montane, and boreal), each with its own distinctive suite of amphibian species (ten in all). Few of these are greatly restricted in range, with the exception of two of the montane species, which are range marginals in this province. For the most part, the ranges of the amphibian species coincide with the margins of the biotic provinces which contain their typical habitat. Species diversity decreases from south to north; few species are adapted to the long winters and cool, unpredictable summers of the boreal forest. The most widespread species in the province is the Boreal Chorus Frog (*Pseudacris triseriata maculata*), which ranges through all of the province except in the montane areas. Distributions of the Alberta amphibian species are given in Russell and Bauer (1991).

Little information is available on the status of most of the amphibian species. The Fish and Wildlife Division of Alberta Forestry, Lands and Wildlife has placed the Great Plains Toad (*Bufo cognatus*), the Long-toed Salamander (*Ambystoma macrodactylum*), and the Leopard Frog (*Rana pipiens*) on their Red List (at considerable and immediate risk in the province; designated or to be designated as endangered - Anonymous 1991). The Plains Spadefoot Toad (*Scaphiophus bombifrons*) and the Spotted Frog (*Rana pretiosa*) are on the Blue List (at risk in the province, but not in immediate danger; also suspected to be vulnerable, but too little known to be otherwise classified - Anonymous 1991); while the Dakota Toad (*Bufo hemiophrys*) is on the Yellow List (sensitive, but not at risk in the province; may benefit from special management - Anonymous 1991). This is a large fraction of the amphibian species known to occur in this province, and indicates the necessity of garnering more information on the range and status of Alberta's amphibians.

THE ALBERTA MONITORING PROJECT

History

The Alberta task force on declining amphibian populations first convened at the Calgary Zoo on January 18, 1992, on the initiative of Carolyn Seburn, of the University of Alberta, who had been at the organizational meeting of the International Union for the Conservation of Nature (IUCN) Declining Populations of Amphibians Canadian Working Group in Burlington, Ontario, in October of 1991. This earlier meeting established a Canadian organization to carry out the IUCN's mandate to examine amphibian populations worldwide, in order to determine whether the apparent global decline in recent years was real or only apparent. Representatives of the Calgary Zoo, the University of Calgary, Alberta Education, the Federation of Alberta Naturalists (FAN), and a number of smaller natural history societies, met to discuss the possibility of setting up local monitoring projects in Alberta, and to organize some sort of administrative body to formulate guidelines, administer funding, and collate data. A basic monitoring doctrine was established, and some volunteer regional coordinators (responsible for organizing volunteer groups in particular areas) stepped forth. A pro tem provincial coordinator also volunteered.

Since then, our efforts have concentrated upon establishing a consistent set of field protocols for taking data, and upon recruiting local volunteer monitoring groups. We have been fortunate to have the participation of the FAN, an umbrella group for the province, which has made tapes of frog calls available to interested local groups and has promoted monitoring activities among its constituent organizations. The FAN has also undertaken to manage our funds for us. Alberta Fish and Wildlife (AFW) has recently expressed interest in undertaking population monitoring. We have directly approached a number of organizations in the province, and have received positive responses, so it looks as though we will be able to conduct our surveys on a largely volunteer basis.

Methods

We intend to undertake two types of monitoring in Alberta; low intensity and high intensity. Low intensity monitoring will be carried out by volunteer groups, and will cover a wide variety of habitats (and species) over, ideally, the better part of the province. A methodology for low intensity monitoring of amphibian populations has been written and distributed to some groups, and to AFW. This protocol depends upon the local monitoring group to decide where they should undertake their activities, although it gives some pointers on selecting a site. Actual monitoring will consist of repeated counts of breeding adults, taken over the length of the breeding season. Egg mass counts must be taken at the same time. We do not recommend attempting to count larvae, as they are hard to identify to species. Counts yield simple but quantifiable data; we are satisfied that population trends, if consistent and directional over several years, should be evident from counts.

At present two high intensity monitoring projects are underway, on Northern Leopard Frog populations over the range in Alberta (undertaken by Carolyn Seburn) and on Long-toed Salamander populations in the Banff-Canmore corridor, undertaken by A.P. Russell and Larry Powell. Both of these projects are partially funded by AFW. Both are mark-recapture projects carried out by professionals, concentrating upon the population dynamics of the target species over a period of at least two years, if not more.

At present, our data repository is with Larry Powell at the University of Calgary.

Prospects

We have managed to get several amateur groups interested in establishing local low intensity monitoring projects distributed over much of the southern part of the province. AFW has expressed active interest in undertaking further low intensity monitoring projects with its own personnel. A protocol for taking low intensity data has been promulgated. We have two high intensity monitoring projects in place. While we feel that it would be desirable to have more groups in place this spring, we have not had a great deal of time to prepare this year, and the start that we've made in 1992 bodes well for 1993.

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THE RANGE AND STATUS OF THE EASTERN SHORT-HORNED LIZARD IN THE CANADIAN PRAIRIES

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INTRODUCTION

The geographic range of the Short-horned Lizard (*Phrynosoma douglassi*) covers much of western North America (Smith 1946, Reeve 1952, Sherbrooke 1981). The six recognized subspecies of Short-horned Lizard range from west-central Mexico in the south to southern British Columbia, Alberta, and Saskatchewan in the north (Reeve 1952, Logier and Toner 1961). The Short-horned Lizard is classed as a non-desert species of phrynosome by Heath (1965), and is found in a variety of habitats over its latitudinal range. In the north of its range it is found in sagebrush communities and semi-arid short grass prairie (Smith 1946, Sherbrooke 1981, Powell and Russell 1984, 1991a). The Short-horned Lizard is always found at high altitudes, but its upper altitudinal limit is closer to sea level in the northern part of its range (Montanucci 1981).

Two subspecies of Short-horned Lizard have been recorded from Canada, the Pygmy Short-horned Lizard (*Phrynosoma douglassi douglassi*) in southern British Columbia, and the Eastern Short-horned Lizard (*P. d. brevirostre*) in southeastern Alberta and southwestern Saskatchewan (Smith 1946, Logier and Toner 1961, Cook 1966, 1984). Here we summarize data on the known range, ecology, and abundance of the Eastern Short-horned Lizard in Alberta and Saskatchewan, and make recommendations concerning management and conservation.

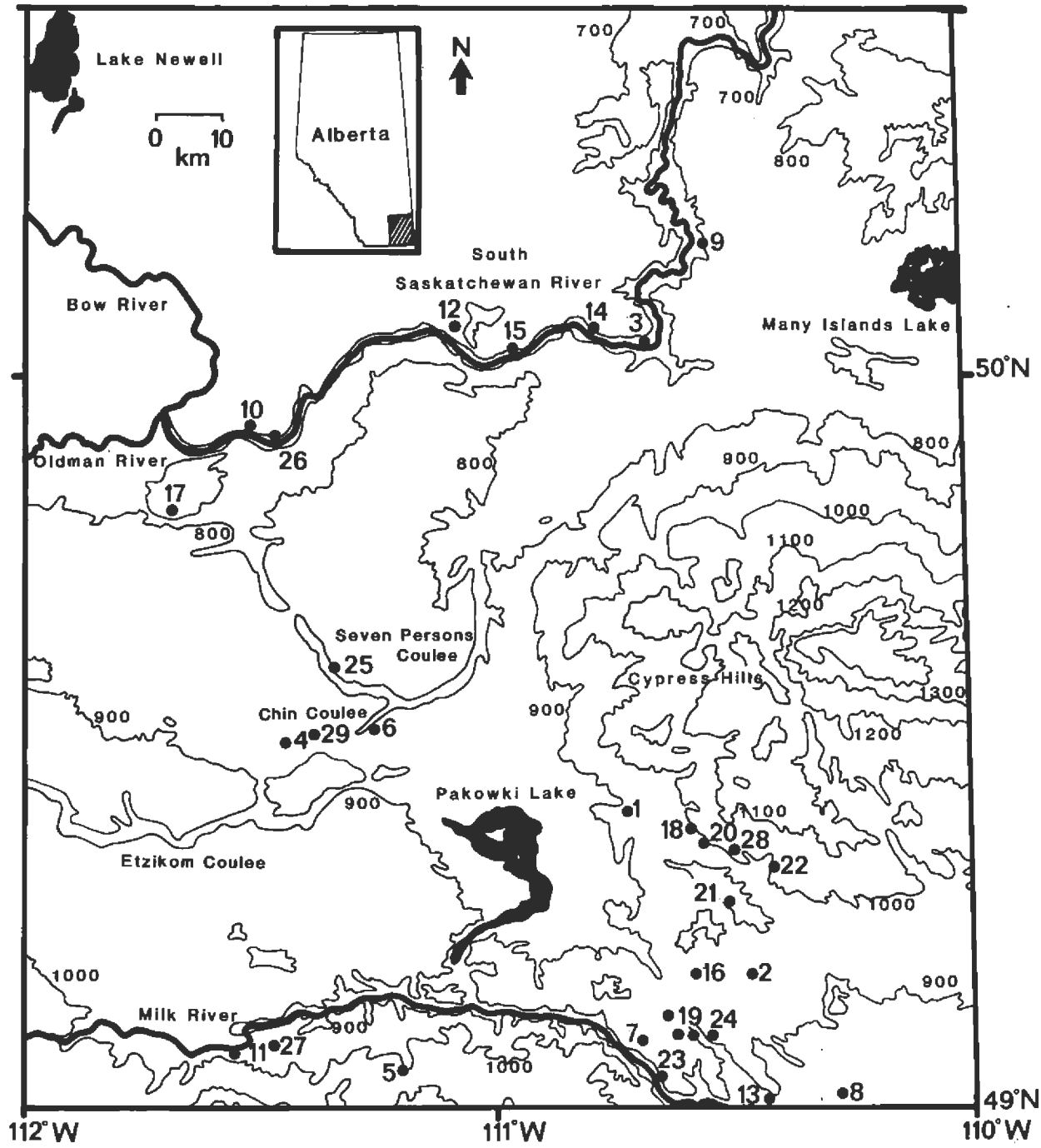
THE RANGE IN THE PRAIRIE PROVINCES

The range of the Eastern Short-horned Lizard is not well-known in Montana, although it is distributed through much of the eastern half of the state; it appears to be contiguous with the known distribution in Saskatchewan, but not with that in Alberta (Thompson 1982).

The range of the Eastern Short-horned Lizard extends north to 50°10′N in Alberta. The distribution appears to be disjunct, one group being found along the South Saskatchewan River, another group distributed through the Milk River and Pakowki Lake drainages (apparently broken into eastern and western subgroups), and the third group at Chin Coulee and 40-Mile Coulee (Figure 1). The South Saskatchewan River valley forms the northern boundary of the recorded range. There are no records east of Wildhorse in this province, and the Cypress Hills limit distribution to the northeast, while to the southwest the Sweetgrass Hills seem to confine populations to the immediate Milk River valley. The maximum elevation at which any population is found is 1035 m, along the southern edge of the Cypress Hills. Most of the rest of the southern populations are found at 900 m. The Chin Coulee populations are found at 800 m, as is the one in 40-Mile Coulee, while those lying along the South Saskatchewan River reside at 700 m.

The soil in the vicinity of Manyberries and Onefour, Alberta, is classified as $B1_5$ in the Soils of Canada Inventory (Clayton et al. 1977), a brown solonetz with a loamy texture. The soils of the remainder of the Eastern Short-horned Lizard's range in Alberta are classified as $A1_{22}$ and $A1_{23}$ (Clayton et al. 1977), both brown chernozemic soils that are loamy in texture. These soil types experience temperatures of 25°C or warmer for less than 120 days of the year. The moisture class is subarid, the soils being mainly dry when their temperature is 5°C or higher. This entire area lies within the dry steppe climatic region of Alberta (Longley 1977). The growing season begins around April 15, and the mean date of the last spring frost is between May 15 and June 1 (Ibid.). Summers are hot, the mean July temperature over the range varying between 19°C and 20°C (Ibid.). The average date of the first fall frost is later than September 15 over the range, for an average frost-free period of 120 days (Ibid.). Total annual precipitation over the range averages 33 cm, most of which falls between April and October, with a peak in July. The climate in the summer over the range can best be described as hot and dry.

The climax vegetation in this part of Alberta is the mixed grass prairie association (Coupland 1950, 1961, North 1976, Wallis 1976). Its dominant successional



1. Manyberries (Logier and Toner 1961; Lewin 1963; NMC 1922; NMC 3482; UAMZ 40; UAMZ 97; UAMZ 122 - 126);
2. Onefour (Logier and Toner 1961; UAMZ 41 - 42; UAMZ 277 - 278; UAMZ 280 - 281);
3. Medicine Hat (Logier and Toner 1961; NMC 356; UAMZ 13; UAMZ 131; D. Berisco, pers. comm.);
4. Chin Coulee at Foremost (Williams 1946; Lewin 1963; NMC 1147; NMC 1830; Powell and Russell 1991);
5. Bear Gulch (Williams 1946);

(cont.)

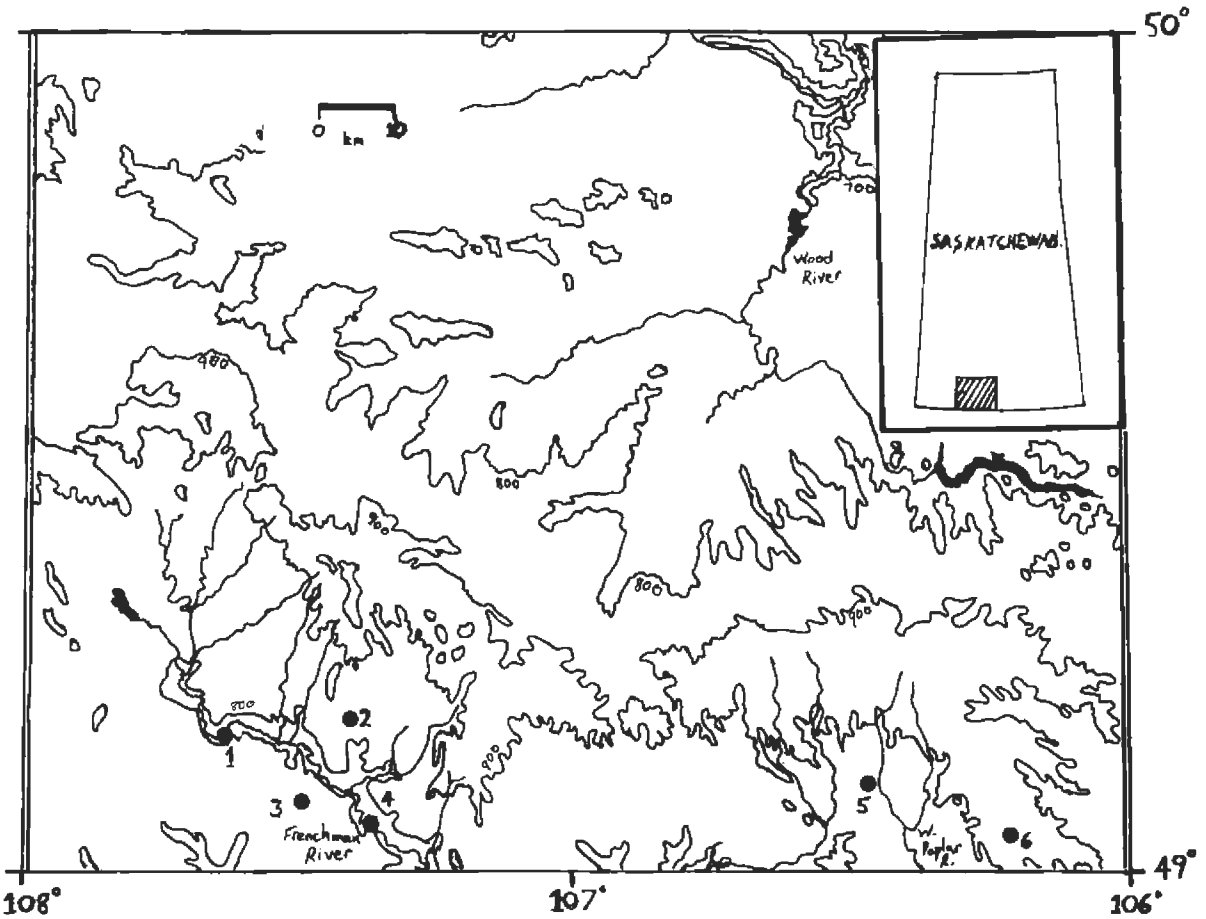
6. Nemiskam National Park (Soper 1949; Powell and Russell 1991);
7. Comrey (Lewin 1963; Powell and Russell 1984; NMC 1857; UAMZ 128; UCMZ(R) 1980.20; UCMZ(R) 1980.21; UCMZ(R) 1980.25; Powell and Russell 1991);
8. Wildhorse (Lewin 1963; UAMZ 276);
9. 16 km NE of Medicine Hat (Schowalter 1979);
10. 9 km NW of the town of Bow Island (Schowalter 1979; Powell and Russell 1984; UCMZ(R) 1980.22; UCMZ(R) 1980.23; Powell and Russell 1991);
11. Audet Ranch (Schowalter 1979; NMC 1829);
12. Rose Ranch, 20 km S of Suffield (Laird and Leech 1980; Powell and Russell 1984; UAMZ 156 - 157);
13. 8 km S of Onefour (Laird and Leech 1980; UAMZ 93; UAMZ 98 - 102);
14. Redcliff (UAMZ 129 - 130);
15. 11 km W of Redcliff (NMC 3479);
16. Lost River Canyon 9 km S of Onefour (NMC 7333);
17. Grassy Lake (NMC 1020);
18. 20 km SE of Manyberries (Strong, pers. comm.; Powell and Russell 1991);
19. Lost River Canyon W of Onefour (Strong, pers. comm.; NMC 1284);
20. 20 km SE of Manyberries (Harder, pers. comm.; Powell and Russell 1991);
21. Nemiskam Community Pasture (Powell and Russell 1984; UCMZ(R) 1980.19; R. Lee, pers. comm.; Powell and Russell 1991);
22. McKinley's Ranch (Powell and Russell 1984; Powell and Russell 1991);
23. North edge of Milk River Canyon (Lewin 1963; Smith 1975; UAMZ 279);
24. Lost River Canyon (Lewin 1963; UAMZ 43; UAMZ 94);
25. 40-Mile Coulee (M. Nelson, pers. comm.);
26. Second Laidlaw (L. Milne, pers. comm.);
27. MacDonald Coulee (Powell and Russell 1991);
28. Lecuyer's Coulee (W. Smith, pers. comm.; Powell and Russell 1991);
29. Chin Coulee 3 km E of Foremost (Powell and Russell 1991).

Figure 1. The distribution of *Phrynosoma douglassi brevirostre* in southeastern Alberta (hatched area of inset map), in relation to elevation and drainage. Elevation in metres. References following each locality document literature reference, specimen number (NMC - Herpetology Section of the Canadian Museum of Nature, UAMZ - University of Alberta Museum of Zoology, UCMZ(R) - University of Calgary Museum of Zoology), anecdotal report (pers. comm.); Powell and Russell 1991 refers to our survey of 1991 rather than to a document.

stage is the *Stipa* - *Bouteloua* fasciation (Coupland 1950). In the drier area south of the Cypress Hills this is replaced by the *Bouteloua* - *Stipa* fasciation (Coupland 1950). Eroded areas throughout the range typically feature the *Agropyron* - *Muhlenbergia* facies, a varied assortment of drought-resistant species (Coupland 1950).

There are relatively few records of the Eastern Short-horned Lizard from Saskatchewan (Secoy 1976) and these sites are disjunct from those in Alberta (Figure 2). Secoy (1976) stated that the distribution is limited to the Frenchman River valley. However, the Killdeer area localities lie in the Poplar River drainage system (Figure 2), which like the Frenchman River is a tributary of the Milk River (and eventually the Missouri). Secoy (1976) suggests that the Eastern Short-horned Lizard may also occur in the area of Big Muddy Creek, well to the east of all recorded Saskatchewan localities.

The range of the subspecies in Saskatchewan appears to be restricted to the northwest by the Cypress Hills, to the northeast and east by Pinto Butte and Wood Mountain, and to the west by the Boundary Hills. The distribution thus extends no further north



1. Frenchman River valley 11 km southeast of Val Marie (Chandler 1965);
2. Gergovia (NMC 1634; Nero 1957; Logier and Toner 1961);
3. Rosefield (NMC 5680);
4. Frenchman River flats (Nero 1957);
5. 8 km west of Killdeer (NMC 15499);
6. Poplar River drainage (NMC files; no specimen).

Figure 2. Known localities of *Phrynosoma douglassi brevirostre* in Saskatchewan (hatched area of inset map). Elevations are in metres. References following each locality document literature reference or specimen number (NMC - Herpetology Section of the Canadian Museum of Nature).

than 49°30'N. The populations in the area of Val Marie and Rosefield lie at approximately 800 m elevation, while those in the Wood Mountain area are found at an elevation of roughly 900 m. Most of the Saskatchewan populations are found in relatively flat, rolling river bottoms. The Frenchman River populations are in an area underlain by the Bearpaw formation, while those in the vicinity of Killdeer live over Ravenscrag bedrock (Richards and Fung 1969, Whitaker and Vonhof 1973). The soil is classed as $A1_{18}$ over most of the range, with some occurrence of $B1_5$. These soils have similar characteristics to their counterparts in Alberta (Clayton et al. 1977). The climate is classified as dry steppe (Longley 1977), with short hot summers and 30 to 35 cm of precipitation annually (Richards and Fung 1969). The average frost-free period ranges in length from 80 to 100 days, beginning from June 1 to 10, and ending between September 1 and 10 (Richards and Fung 1969). The vegetation is mainly the *Bouteloua - Stipa* fasciation (Coupland 1950), in other regards being similar to the range in Alberta.

HABITAT

Alberta

In Alberta, the Eastern Short-horned Lizard is generally found on south-facing slopes of the upper reaches of coulee or canyon slopes (Williams 1946, Soper 1949, Lewin 1963, Halladay 1965, Wallis 1976, Milner 1979), and Bearpaw shale outcrops (McCorquedale 1965). Short-horned Lizard habitat in Alberta can be divided into three types, defined partly by geographical distribution and partly by their differences in various biotic and abiotic characteristics (Powell 1982, Powell and Russell 1991a). These habitat types are defined by qualitative rather than quantitative characteristics, and are not exclusive categories.

Milk River Basin

Site numbers 2, 5, 7, 8, 11, 13, 16, 19, 23, 27 (Figure 1) are associated with the immediate Milk River valley and canyon and with its drainage basin and tributaries (i.e., Lost River) to the east. In this area, populations are generally found upon ecotones, particularly coulee and canyon rims mostly on south-facing slopes. There are anecdotal reports of Short-horned Lizards in this region being found in grassland areas, not near any local break or ecotone, and of them being encountered in coulee bottoms (L. Piotrowski, pers. comm. 1979; P. Stern, pers. comm. 1991). Populations in this habitat type are not abundant to the west, where they appear to be restricted to coulees closely associated with the south side of the Milk River. To the east, populations cluster more thickly; it is from this region (eastern Milk River canyon, Lost River canyon, and breaks north of Onefour) that almost all of the reports of wandering Short-horned Lizards in grassland areas come.

Biotically, this area is typical short grass prairie. The terrain is generally rolling, with frequent exposures of bedrock in coulee and canyon edges, and associated clayey badland areas. The topsoil is generally extremely thin in areas where lizards are found, and burnouts (areas where the topsoil has been eroded away to expose the underlying clay) are common around coulee edges. Most exposed substrate is hard-packed.

Bearpaw Habitat

Site numbers 1, 18, 20, 21, 22, 28 (Figure 1) found along the southern edge of the Cypress Hills plateau, on the north and south sides of Manyberries and Sage Creek valleys. They are invariably associated with extensive surficial exposures of Bearpaw shale, which is very friable, and breaks down to form stretches of distinctive dunes. Creeping Juniper (*Juniperus horizontalis*) is the dominant plant on this substrate, forming large mats which serve to anchor the dunes, but total vegetation cover in these juniper dune areas is not greater than 50%. This terrain occurs in broad shallow ravines, coulees, and steep slopes on the southern and western edge of the Cypress Hills plateau. The higher areas between juniper dune terrains are flat or gently sloping, and generally support a typical short grass prairie vegetation. This terrain predominates over the ridge, forming the southern side and much of the north side of the common valley of Manyberries and Sage Creeks, and the southwestern and western edge of Cypress Hills.

Not all such terrains within the bounds of the range in Alberta can be said to support Short-horned Lizard populations; those lying as far north as the lower reaches of Seven Persons Coulee may be at too great an elevation although more extensive searching is necessary before this can be stated with certainty. We have only two reports of them being found far from juniper dune terrain in this area. However, they do use adjacent grasslands. Aspect varies greatly within these terrains, and slopes of all orientations are used by Short-horned Lizards. The dark colour of the substrate absorbs heat and undoubtedly contributes to this flexibility in orientation.

We do not know how far to the east, or to the north, this lizard is found on terrain of this sort, but suspect that there are more in both directions than have been so far enumerated. This set of sites probably represents a contiguous lizard population and thus represent the largest population, and largest concentration of suitable habitat, in Alberta.

North Marginal Habitat

Site numbers 3, 4, 6, 9, 10, 25, 26, 29 (Figure 1) are scattered along Chin and 40-Mile Coulees, and along the South Saskatchewan River. We refer to their habitat as marginal because these populations appear to be restricted to the south facing canyon and coulee edges, and because this is the northern limit of lizard range in Alberta. The surrounding area is generally flat short grass prairie, with relatively little relief. The valleys are generally 1 km wide or more. Short-horned Lizards are usually found along the channel edges which are elaborated into series of spurs and draws, producing slopes of varying grades and aspects. Generally the slopes are vegetated thinly and on their upper third

or so. Short-horned Lizards are most often found on this upper third, seldom descending to the bare lower slopes almost never being found upon the flat grasslands at the tops. The elevations of the tops of the channels vary between 875 m and 700 m. Soils on the upper slopes are sandy and friable. Although it is difficult to be sure, populations in habitat of tbis type appear to be far more widely scattered and rarer than those in the other habitat categories in Alberta.

Saskatchewan

The Eastern Short-horned Lizard is limited to the short grass prairie area of the southwest where it is found in the badlands (Secoy 1976, Chandler 1965) often where there are outcrops of blue shale (Nero 1957). This association of the species with badlands (especially "blue shale" badlands) and the predominance of the Bearpaw formation through this area (Whitaker and Vonhof 1973) suggests that the species in Saskatchewan is largely restricted to habitat very much like the Bearpaw habitat classification in Alberta. The requisite bedrock is not found in the area occupied by the populations in the Killdeer area (Whitaker and Vonhof 1973), but we have fewer reports from this area.

GENERAL BIOLOGY

Courtship and mating in Short-horned Lizards are described by Montanucci and Baur (1982). Reproduction is described by Goldberg (1971), Guyer (1978), and Guyer and Linder (1985). Clutch size ranged from six to thirteen young in Alberta (University of Alberta Museum of Zoology specimen number 131) (Laird and Leech 1980, Powell and Russell 1991b). Neonates averaged about 24 mm in snout-vent length (SVL), and weighed an average of 0.7 g (Powell and Russell 1991b). Sex ratios varied between clutches, but overall was approximately 50:50 (Powell and Russell 1991b). Parturition occurs from the last week of July to the first week of August, and seems to be synchronized—no gravid females were found in any of tbe Alberta populations examined after the first week of August (Powell and Russell 1991b). There are indications that parturition takes place around noon. Survivorship of the young has not yet been assessed. Gravidity evidently imposes a considerable physiological strain on reproducing females, and this may act as a limiting factor, since they must recover lost weight in a limited time period before the onset of hibernation (Powell and Russell 1991b).

Sexual maturity in males is attained in the summer after the first winter dormancy but has not been determined for females (Powell and Russell 1985b). Males attained an average adult SVL of 50 mm and an average adult weight of 10 g while females average adult SVL was 70 mm, and average adult weight approximately 18 g. This disparity in adult size between the sexes was probably related to the species' viviparity (Powell and Russell 1985b). Recapture records suggest that females lived as long as five years (Powell and Russell 1985b), but no such estimate can yet be made for male lifespan.

The earliest activity record for the Eastern Short-horned Lizard in Alberta is April 27 (Laird and Leech 1980), and the latest is September 25 (Powell, pers. obs.). Most activity has ceased by the second week of September. The average active season is thus approximately 150 days long. The mean date of the last spring frost is well after the start of yearly activity, which suggests some ability to resist freezing or at least to avoid freezing conditions. These populations exhibit considerable breadth in active body temperature (Powell and Russell 1985a) and this may be important in extending daily activity periods early in the active season and in permitting activity on cool, overcast days. Most lizards have disappeared by the mean date of the first fall frost, presumably having entered winter dormancy. Yearly activity pattern may be controlled by an endogenous cycle triggered by photoperiod since there appears to be little change in environmental temperature over the period in which the lizards cease to be active (Powell and Russell 1985a). The location and nature of hibernacula used by the Alberta populations are unknown, although Short-horned Lizards have been observed moving off an ecotone and into the adjoining badlands at the end of August (Powell, pers. obs.)

Phrynosomes are specialized ant eaters (Pianka and Parker 1975). The Eastern Short-horned Lizard does feature a high proportion of ants in its diet in Alberta, but also preys heavily on beetles and grasshoppers (Powell and Russell 1984). There is some partitioning of the dietary niche between the two sexes; females, due to their greater size, take larger prey items and also a wider size range of prey than males (Powell and Russell 1984).

POPULATION TRENDS

No appropriate field work to indicate population trends has been conducted in Saskatchewan. Data

concerning population size and trends, supporting only the most tentative conclusions, are available for four of the Alberta populations of the Eastern Short-horned Lizard (Powell 1982, Powell and Russell 1992). There are no data on possible size fluctuations in these populations in the intervening eleven years.

A great decrease in number was noted at two of Powell's (1982) localities since the systematic field work of 1979 to 1980. Capture success at the two other localities varied greatly in 1979 to 1980, but appeared to reflect a constant population size (Powell and Russell 1992). Success in capturing lizards at any "new" locales examined in the summer of 1991 is consistent with a general decrease in population sizes, and with the extirpation of some populations (40-Mile Coulee, Medicine Hat) (Powell and Russell 1992). Only one site of the fourteen visited by Powell and Russell (1992) in the summer of 1991 yielded large numbers of Short-horned Lizards. While general capture success is suggestive of diminished population sizes almost everywhere, this is a subjective judgement in the absence of comparable earlier data from all but four populations. Also subjective are several independent observations by long-time residents near some Alberta localities, that the lizards are much less frequently seen in recent years.

Powell and Russell (1985a), as a corollary of their growth models for the Alberta Short-horned Lizard populations, extrapolated a population size distribution, for each sex, to be expected over the active season. These depend strongly upon a reasonably invariant yearly average date of parturition, but observation so far suggests that this is a reasonable assumption (Powell and Russell 1985a, 1991b). Powell and Russell (1992) plotted the SVLs (all females and males [Figure 3]) of 1991 Alberta captures, against the day (since January 1, 1991) of capture, superimposing these upon the projected and observed size distributions for each sex for 1979 (from Powell and Russell 1985a).

Both distributions of 1991 lizard sizes conform well to the modelled sex-specific distributions of Powell and Russell (1985a) (Figure 3). However, few females from the 1991 field season were within the adult size range, and of these, none were as large as the large females captured in 1979; few were within the size range typical of females born the previous year (Figure 3). Males are less easily divided into age classes, due to the early cessation of growth in this sex (Powell and Russell 1985a). However, it is evident that

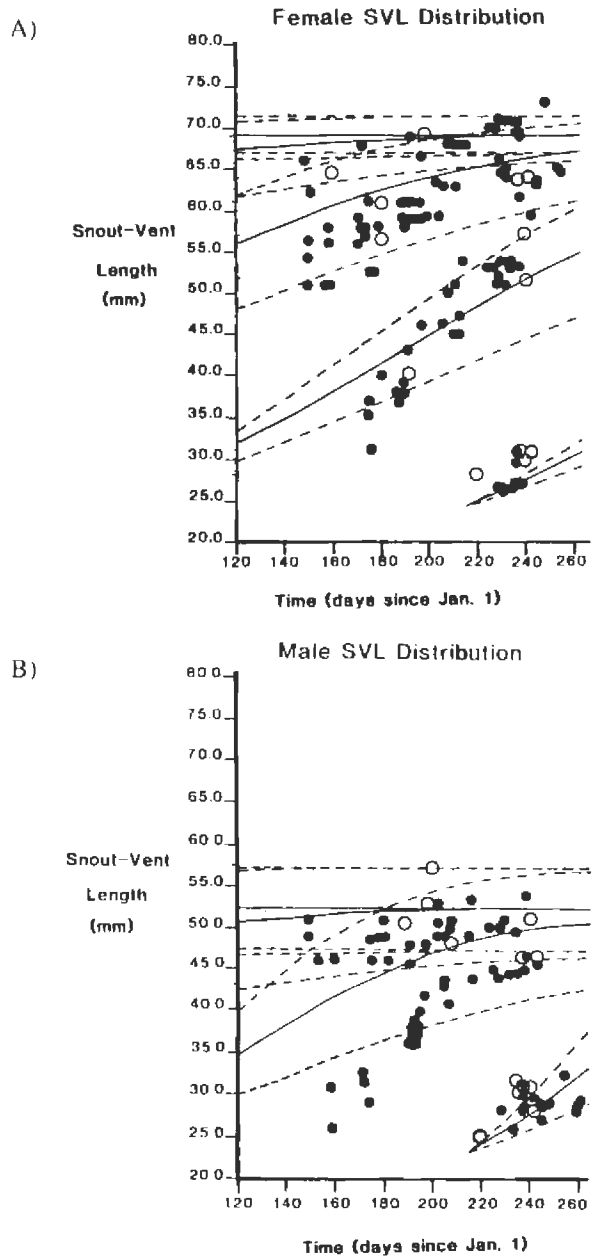


Figure 3. Distribution of snout-vent lengths of all female *Phrynosoma douglassi brevirostre* captured in Alberta in 1979 against day of the year, with superimposed modelled cohort growth patterns and snout-vent length distributions of all female (A) and male (B) Short-horned Lizards captured in Alberta in 1991. Solid circle - observed snout-vent length of 1979 capture; solid line - predicted growth trajectory of one female cohort; dashed lines - upper and lower 95% confidence limits for predicted growth trajectory; open circle - observed snout-vent length of 1991 capture. After Powell and Russell (1992), modified from Powell and Russell (1985a).

almost all males captured in 1991 were of adult size, except for the neonates born that year, a distribution quite different from that displayed by the 1979 captures (Figure 3). There are too few points to allow any firm statements, but both distributions show a marked lack of lizards which were of a size to have been born in the previous year, and in the case of females, of very old individuals (Figure 3). This is consistent with a bottleneck in population sizes over the geographic range examined by us.

The low rate of capture in 1991, the observations of knowledgable locals, and the pooled lizard size distributions, all independently suggest that Short-horned Lizard population sizes have declined throughout the range in Alberta since Powell (1982) did his field work (Powell and Russell 1992). From what information we have available, it is impossible to say whether this is a long-term trend dating from the last organized field work, or a relatively new product of forces operating over the past two or three years. The prolonged drought that the province has sustained suggests itself as an immediate cause. Population decrease has occurred in localities, such as Comrey and Nemiskam Community Pastures, where little or no human activity has taken place over the last eleven years, as well as in localities such as Bow Island where human agencies could conceivably have been at work. Drought, through its depression of productivity and hence insect populations, could act to lessen Short-horned Lizard fecundity and so produce a cumulative decrease in population size over the range (Powell and Russell 1992).

The status of the Saskatchewan populations remains nebulous. Almost all of these localities are represented by single specimens (Nero 1957, Chandler 1965, Secoy 1976), which is suggestive of rarity, but this was true of the Alberta populations until Powell (1982) looked systematically at some of these locales and found that the species was more common than had been previously thought. Nero's (1957) correspondent noted that the species was relatively abundant in the Rosefield area, but that was in 1957.

HUMAN IMPACTS

Once again, we have a much better understanding of human impacts in Alberta than in Saskatchewan. In Alberta they can be broken down into four major categories, which are of varying importance in different parts of the range in this province.

Grazing

Grazing is the primary large-scale human-fostered activity in the southeast quarter of Figure 1, and predominates over much of the rest of the area in which Short-horned Lizard populations are found: in fact, they are not likely to persist in localities where this is not true. Grazing is at worst a neutral activity as far as Short-horned Lizard populations are concerned. Direct effects on individual lizards would extend no further than the small and avoidable chance of getting stepped on by a cow. Grazing intensity will affect the composition of the vegetation in a particular spot. However, unless there are enough cattle on a particular plot of land to reduce it to a dustbowl, this sort of indirect effect is most likely to favour Short-horned Lizards than otherwise. Pygmy Short-horned Lizard, in sagebrush-dominated range in Idaho, maintained larger populations upon grazed rather than ungrazed areas, apparently responding positively to the removal of ground cover (Reynolds 1979). Short-horned Lizards in Canada are likely to do the same. In any case, they are largely found in areas (such as juniper dune terrain and coulee edges) where cattle tend not to congregate. The only deleterious aspects of cattle grazing (which after all does not differ greatly from bison grazing, a probable factor in the evolution of this species) is range improvement by the planting of such forage as Crested Wheat Grass (*Agropyron cristatum*), an activity which few ranchers seem to undertake; and mechanical damage to coulee rims by large numbers of cattle on their way to water. Cattle-related improvements, such as devoting coulee bottoms to haying, or excavating dugouts, do not directly affect Short-horned Lizard habitat, as far as we can tell.

Cultivation

This is a secondary human use of the area over which Short-horned Lizards are found in Alberta, although it predominates in the irrigated district between the South Saskatchewan River and Chin Coulee. Cultivation is uncommon in the area south of the Cypress Hills and Milk River.

Land which is liable to cultivation is not likely to be Short-horned Lizard habitat, as they seldom make much use of either coulee bottoms or flat terrain with no exposed bedrock. The extent to which they are affected by agriculture depends upon the extent to which the farmer uses his marginal land. The Chin Coulee population immediately northeast of Foremost

(Figure 1, Number 29) lives on upper coulee slopes below cultivated land, but persists along much of the coulee's length, likely because cultivation does not approach the edge very closely. The 40-Mile Coulee population (Figure 1, Number 25) may have diminished because cultivation on the east side of the coulee comes very close to the coulee edge below the dam. Populations in South Saskatchewan River valley habitat in Alberta, which are found in the main stretch of cultivated land between Foremost and the South Saskatchewan River, appear to be restricted to the upper reaches of coulee or canyon slopes. Circumscribing these closely with cultivated land will allow agricultural chemicals to readily drain off into Short-horned Lizard habitat, and will reduce the prairie "hinterland" at the top, which the upper slopes may draw upon as a biotic reservoir, even though Short-horned Lizards do not appear to use this topside terrain directly. These constraints will mainly affect populations to be found along Chin and 40-Mile Coulees, plus any which may exist along Seven Persons Coulee.

Irrigation works themselves may have impacts upon adjacent populations, although this is difficult to demonstrate directly. It is interesting that the only recent large-scale irrigation work within the Alberta range, the new dam and reservoir in 40-Mile Coulee, is the site of one of the few recorded Short-horned Lizard populations which Powell and Russell (1992) concluded was extinct. If Short-horned Lizards were found on the slopes above where the reservoir now lies, they may have been adversely affected by the flooding of the lower slopes, or possibly the hibernaculum used by this population was flooded. More work is required to establish the connection, if any, here.

Agriculture is not likely to greatly affect existing populations unless its extent is greatly increased, and unless marginal terrain is consistently ploughed.

Oil and Gas Exploration

The presence of buried gas lines has been noted at some Alberta localities. These do not appear to have a great effect on Short-horned Lizard populations, although their installation has undoubtedly resulted in some disruption.

The major impact of the oil industry is through exploration and extraction. Populations confined to the immediate neighbourhood of riverside bluffs or coulee edges would not be greatly affected by these activities, as they are in fairly inaccessible terrain. Oil-related development has two main effects in the juniper dune habitat lining the Manyberries Creek/Sage Creek valley. Vehicular tracks disturb the terrain, and pose a traffic hazard to Short-horned Lizards, which will tend to disperse through grassy areas via these tracks. The tracks also provide vehicular access for other vehicles. Drilling rigs are installed in the middle of perhaps unnecessarily large bare platforms, which are not reclaimed, whether the hole is a dry one or a pumpjack is installed. This elimination of the natural vegetation, on tracks and on rig platforms, destroys habitat which lizards would otherwise use, and opens the friable Bearpaw substrate to wind and water erosion to an even greater extent than usual. This terrain is delicate, its structure being maintained to a large extent by the slow growing juniper mats, and it is difficult for vegetation to colonize even in its relatively stabilized form.

The effects of this disturbance are not easy to assess, because we have no data on population sizes in the affected areas before the greater part of the development was put in. Short-horned Lizards are evidently persisting in the developed area, but appear to have declined in number in the area of the greatest development, around Manyberries Hills. Some effort at reclamation is needed, but none has been made, except on the most recent well (1990) drilled in this area.

Urbanization

This is of concern to few populations in Alberta. The growth of Medicine Hat north of the South Saskatchewan River has likely caused the recent extirpation of at least one Short-horned Lizard population within the urban area. Unfortunately we cannot tell if there are or were other populations within the Medicine Hat city limits, since none of the records that we have from here are more specific than "Medicine Hat." Urbanization impinges upon Short-horned Lizard populations directly, by destroying habitat, which is frequently very limited in extent to begin with. It also exposes adjacent lizards to hazards of urban life, such as predation by cats and dogs, collection by interested amateurs and small children, and being run over. Populations which are found in untouched and undesirable riverside areas close to towns, such as, apparently, the Redcliff population, will not be directly affected, but are likely to diminish due to long-term diffuse effects of the sort listed above.

PROTECTION

The Alberta Committee on Rare and Endangered Species (Alberta Forestry, Lands and Wildlife) has determined the status of the Eastern Short-horned Lizard to be "threatened" (C.J. Ward, in litt., February 9, 1979, Roberts 1982). It is protected provincially under the Wildlife Act and associated regulations, and has been accorded a position on the provincial Red List (considered for designation as endangered species in Alberta - Anonymous 1991). Very few of the populations in Alberta lie within protected areas. The Milk River Natural Area encompasses the Comrey population, and any populations which may lie on the south side of the Milk River (Anonymous 1984). Exploration and development of a petrochemical site in the Bearpaw Habitat where Short-horned Lizards are known to occur now requires impact assessment and impact mitigation, but this is a relatively recent imposition. All reptiles and amphibians are protected under the provincial Wildlife Act in Saskatchewan, and the Eastern Short-horned Lizard has no particular status in that province. The western block of the Grasslands National Park harbours the four known Short-horned Lizard populations in the Frenchman River valley (Figure 2) which will be protected by the National Parks Act when the park is incorporated (P. Minton, pers. comm., November 14, 1984). A decision on the COSEWIC (Committee on the Status of Endangered Wildlife in Canada) status (Cook and Muir 1984) of the species in Canada is pending this year; we have recommended that the Alberta and Saskatchewan populations of the Eastern Short-horned Lizard be classed in the COSEWIC vulnerable category (Note - approved by COSEWIC in April 1992). The species has no protection in Montana (D.L. Genter, pers. comm., September 23, 1991), where the only possible contiguous populations to those in Canada are to be found (Thompson 1982).

RECOMMENDATIONS

We strongly recommend that more inventory work be done, in order to establish the true distribution of populations in Alberta and particularly in Saskatchewan. We have visited half of the localities given in Figure 1 (Powell and Russell 1992), but the lengths of Chin Coulee, Etzikom Coulee, 40-Mile Coulee, and Seven Persons Coulee all merit inspection. The range in Saskatchewan is established largely on the basis of anecdotal reports. The Frenchman River valley needs systematic inspection, as does the Poplar River drainage near the United States border, and possibly the Big Muddy Creek valley (Secoy 1976). Until distributions, habitat, and abundances are known for both provinces, a conservation policy cannot be properly formulated.

We would recommend that some long-term monitoring of population trends at selected localities be undertaken. We have already noted that we have almost no data on fluctuations in population size of this species in Alberta. What comparative data we do have suggests that population sizes have shrunk considerably over the past ten years. It could be a cyclic phenomenon which we have happened to catch at two different points. A simple mark-recapture program at selected localities in Alberta (Bow Island, Manyberries Hills or LeCuyer's Coulee, and Comrey) would not yield data suitable for formal population estimates, but repeated over a number of years, would indicate whether or not the populations are declining. The Manyberries Creek/Sage Creek valley populations of Alberta should in particular be monitored in this way, in order to assess the impact of the oilfield development there, since this is very important habitat. This is not to say that a proper, long-term demographic study would be out of place, but a monitoring program of the sort we have outlined is easier to set up and maintain. The true trend in numbers among at least some of these populations must be identified before any decisions regarding management and protection can he made.

Once the species is better known in Saskatchewan, a similar program should be initiated there; given the location of most of the known populations within Grasslands National Park, this would probably best come under the aegis of the National Parks Service.

We recommend that the legal and biological status of the Eastern Short-horned Lizard in Alberta and Saskatchewan be more widely disseminated publicly. The Alberta Ministry of Fish and Wildlife has been distributing posters and illustrated pamphlets documenting species whose statuses are of concern in this province. A similar poster or pamphlet for the Eastern Short-horned Lizard would he of benefit in two ways. It should discourage idle collection and would sensitize landowners, leaseholders, and planners to the habitat requirements of the species. It could also serve as a request for data from the public, asking those who know of populations of this species to respond and inform the authorities. Similar mail-in campaigns are currently in place for Leopard Frogs (*Rana pipiens*) and Western Hognose Snakes (*Heterodon nasicus*) in

Alberta. Recommending campaigns of this sort for Saskatchewan is perhaps premature until we have a better idea of how abundant and widely distributed the species is there, and what kind of pressures it is under.

We recommend that an effort be made to discover the location and nature of at least one hibernaculum used by a population of Short-horned Lizards. We have no clear idea of where they overwinter, and yet it is a critical habitat feature for all reptile species in this climate. This would require a short-term radiotelemetry study of several individuals at one site, in order to follow them when they seek shelter for the winter in early fall. The hibernaculum (or hibernacula—they may den up separately) must be identified for any population if its habitat is going to be properly protected.

Finally, we recommend that the effects of irrigation and agricultural practices on adjacent populations of Short-horned Lizards be examined. We have some tentative indications that these effects exist and are deleterious, but the question must be approached systematically.

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STATUS OF THE PRAIRIE RATTLESNAKE AND THE EASTERN YELLOW-BELLIED RACER IN SASKATCHEWAN

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ABSTRACT

In Saskatchewan, the Prairie Rattlesnake (*Crotalus v. viridis*) and the Eastern Yellow-bellied Racer (*Coluber constrictor flaviventris*) are considered threatened species of wildlife for which there is no open hunting season. Both species have small, restricted distributions and use communal hibernacula. In 1988 and 1990 to 1991 we conducted surveys for hibernacula and initiated mark-recapture studies on these species in order to better delineate their distributions, document life-history parameters and population demography, and identify existing and potential factors which threaten the existence of these species.

We located 22 Prairie Rattlesnake hibernacula, 12 along the South Saskatchewan River west of Leader and 10 in the Frenchman River Valley east of Val Marie. We estimated a total population of Prairie Rattlesnakes in the province of between 2000 and 4500 individuals. The Prairie Rattlesnake is slow growing and females produce their first litter at about five years of age. The average litter contains eight to 10 young and females probably follow biennial or triennial reproductive cycles. Adult snakes make up the bulk of the population present at dens, presumably neonate and juvenile survivorship is poor.

Twenty-three Eastern Yellow-bellied Racers were captured at nine of the 10 hibernacula in the Frenchman River Valley. Racers are more common than was previously suspected, occurring in low densities throughout the valley. Too few captures were made to be able to say much about life-history parameters, except that the presence of neonates and juveniles among the racers captured suggests that populations are managing to sustain themselves.

Most of the communal hibernacula in Saskatchewan are located on Crown land used for grazing or are within the proposed boundaries of Grasslands National Park. There have been several documented acts of malicious killing of Prairie Rattlesnakes and damage done to dens in the recent past. These are isolated events and confined to well-known dens that have easy vehicle access. The majority of hibernacula are located in remote, uninhabited areas and have received little or no human disturbance. The effects that grazing and farming have on rattlesnakes is largely unknown, but is probably minimal at this time. Recommendations for the management and conservation of these species are discussed.

INTRODUCTION

Relatively little is known concerning the distribution, abundance, and natural history of the twelve reptile and seven amphibian species that occur in Saskatchewan. A few species are considered common over much of the south-central regions in the province (e.g., the Common Garter Snake [*Thamnophis sirtalis*], the Northern Chorus Frog [*Pseudacris triseriata maculata*], the Leopard Frog [*Rana pipiens*]). Most species, however, appear to have restricted or poorly delineated distributions in southern Saskatchewan and are uncommon within their known ranges (e.g., the Prairie Rattlesnake, the Short-horned Lizard [*Phrynosoma douglassi*], the Eastern Yellow-bellied Racer and the Western Hognose Snake [*Heterodon nasicus*]; Cook 1978).

Low population densities and patchy distributions within poorly delineated ranges make field investigations of Canadian herpetofauna challenging. For most species in Saskatchewan, field surveys have not been undertaken to ascertain whether populations have been declining, maintaining themselves, or are expanding. In recent years, however, much has been learned about the Prairie Rattlesnake and other prairie snake species using communal hibernacula (Gannon 1980, Gannon and Secoy 1984, Mackay 1987, Macartney and Weichel 1989).

The Prairie Rattlesnake has a disjunct distribution in Saskatchewan. There is a small southern population along the Frenchman River Valley southeast of Val Marie and a small northern population confined to a 50 km stretch of the South Saskatchewan River from near the Alberta border at Estuary, east to about Leader, Saskatchewan. Both the northern and southern populations represent extensions of the distribution of

the Prairie Rattlesnake northeast from Alberta and north from Montana respectively.

The Eastern Yellow-bellied Racer is known only from a few specimens collected or captured in the Frenchman River Valley (Cook 1978, Mackay 1987) and in the Big Muddy Valley of southern Saskatchewan (Maher and Beck 1964, Morrison 1969, Cook and van Zyll de Jong 1975, Kreba 1978). Like the Prairie Rattlesnake, these populations represent the northern most extent of the species distribution in North America. Virtually nothing is known of the biology or population status of this species in Saskatchewan.

In the autumn of 1987, a survey of Prairie Rattlesnake hibernacula (dens) in Frenchman River Valley was conducted for the Saskatchewan Natural History Society (SNHS). This survey identified five active hibernacula, estimated population composition and size, and provided documentation of an incident of deliberate destruction of 40 to 60 rattlesnakes at one well-known rattlesnake den near Val Marie (Mackay 1987).

The northern population of the Prairie Rattlesnake was the focus of a second study commissioned by the SNHS in 1988. Twelve active dens were identified and a more detailed examination of life-history parameters and demography of this population was made (Macartney and Weichel 1989). This study uncovered recent acts of vandalism and rattlesnake killing at two dens near Leader, Saskatchewan. Potential threats to this population due to human disturbances and land use changes were also identified. A provincial rattlesnake population size estimate based on a minimum of 17 known rattlesnake dens ranged from 1200 to 4000 rattlesnakes.

In 1988, the legal status of the Prairie Rattlesnake in Saskatchewan changed when Order-in-Council (782/88, September 1988) amended the Wildlife Act Regulations (4.1a) by expressly excluding the Prairie Rattlesnake from a list of wildlife not protected by closed or regulated hunting seasons. It thus became illegal to kill or capture rattlesnakes (without a permit) except when landowners are threatened on their own property. The same regulatory amendment was also applied to the Eastern Yellow-bellied Racer and the Short-horned Lizard. This legislation, however, offers no specific protection for the hibernacula used by these species.

In 1990/1991, an additional survey for Prairie Rattlesnake populations in southwestern Saskatchewan was commissioned with funds allocated through the Saskatchewan government's Endangered Species Fund. The objectives were to provide a more detailed investigation of the southern population of the Prairie Rattlesnake to further delineate the distribution of active dens in southwestern Saskatchewan, to collect demographic information for this population, and to identify existing or potential threats to these populations. Concurrent objectives were to gather as much information as possible on the life-history, distribution, and population status of other sympatric reptile species, most notably the Eastern Yellow-bellied Racer, during the course of performing field surveys for rattlesnakes. This species is sympatric over most of the range of the Prairie Rattlesnake in North America, often shares the same hibernacula and thus is often encountered while searching for rattlesnakes.

The findings of the 1988 and 1990 to 1991 surveys formed the basis for management recommendations for the protection and conservation of the Prairie Rattlesnake and the Eastern Yellow-bellied Racer in Saskatchewan. The results presented in this paper are a compilation of the 1988 survey of the northern population and the 1990 to 1991 survey of the southern population.

METHODS

Field work was conducted in the spring, late summer, or early autumn, periods when snakes were present at hibernacula. Hibernacula were located on the basis of information provided by local residents, conservation officers, previous studies and by systematic ground searches carried out in areas that provided suitable topography for hibernacula. We also attempted to confirm historic or recent reports of rattlesnakes or their hibernacula outside of their documented range in the province by conducting telephone and in-person interviews with Prairie Farm Rehabilitation Administration pasture managers, local residents, naturalists, and conservation officers.

The locations of active hibernacula were mapped and inspections of the den site and adjacent habitat were made to determine current land use at the site and look for evidence of natural or man-made disturbance at dens (e.g., erosion, shotgun shells, carcasses, chemical, or structural damage to dens).

On each visit to a hibernacula we attempted to capture and mark as many snakes as possible. Rattlesnakes were captured with Pilstrom tongs and secured

for safe handling in a padded restraining noose (Gregory et al. 1989). Non-venomous snakes were captured and restrained by hand. Each snake was sexed by hemipenal eversion (Gregory 1983), its snout-to-vent length (SVL) was measured (stretched out along a metre stick) to the nearest 0.5 cm and the number of rattle segments was counted for every rattlesnake. Snakes were individually marked by removing a unique combination of subcaudal scutes with a pair of scissors (Blanchard and Finster 1933).

Abdominal palpation was used to detect the presence of follicles, eggs, or embryos in female snakes and thereby determine their reproductive status (Macartney and Gregory 1988). Size at sexual maturity was estimated as the SVL of the smallest female found to be gravid or have enlarged follicles (Macartney et al. 1990). All snakes were released to their capture site immediately after processing in the field was completed.

RESULTS

Locations of Rattlesnake Hibernacula

In Saskatchewan, the Prairie Rattlesnake occurs as two small, widely separated, disjunct populations (Figure 1). The northern population is found along a 50 km long stretch of the South Saskatchewan River from the Alberta border near Empress east to about Leader, Saskatchewan. Within this range 12 hibernacula were identified and a total of 130 rattlesnakes were marked during the 1988 survey. Hibernacula in this area were generally situated in areas of slumping topography within a band of about two km from the river. Snakes using these dens are reported to disperse during the summer up to 15 km from the dens, along the river valley floor and upland country, much of which is under cultivation. Numbers of snakes

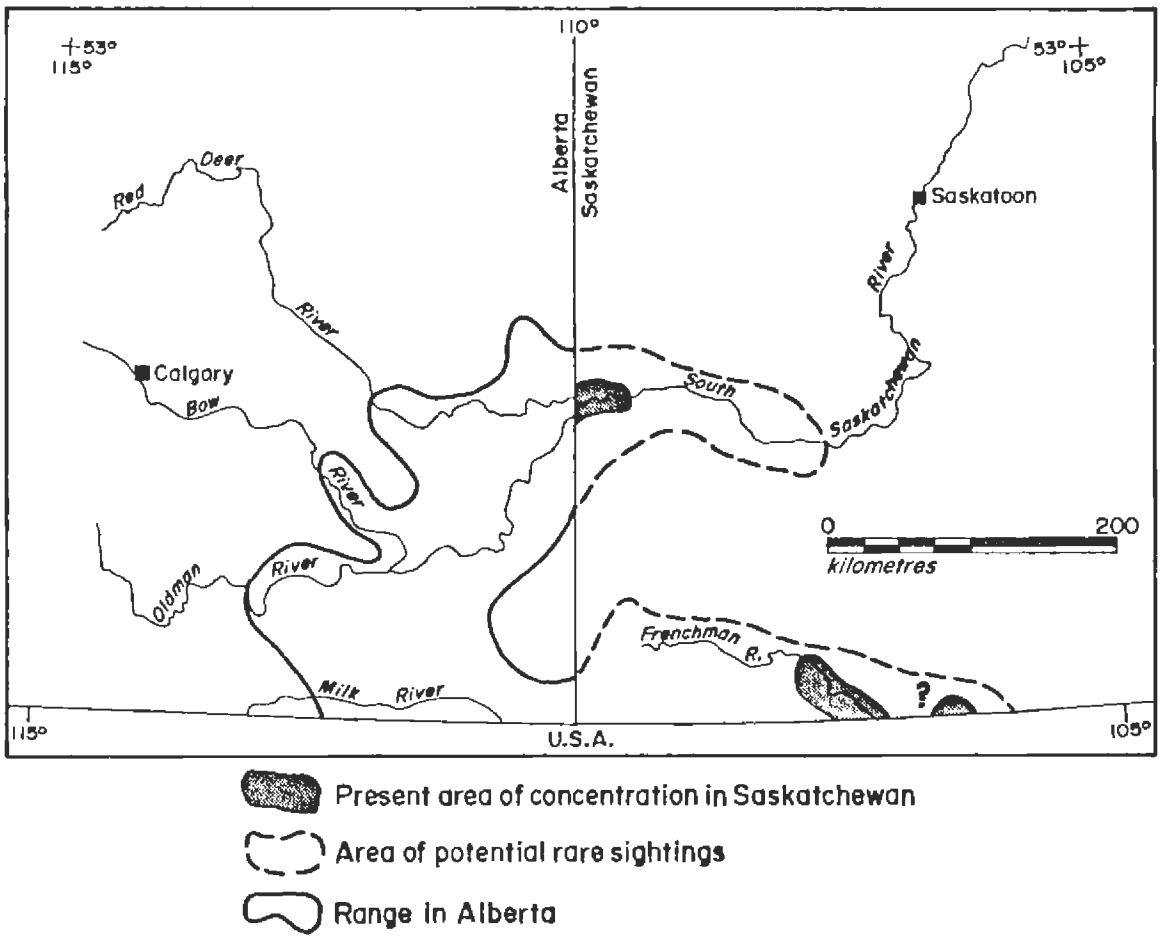

Figure 1. Distribution of Prairie Rattlesnakes in Saskatchewan.

captured at these hibernacula varied from one to 41. Bullsnakes (*Pituophis melanoleucus*) and two species of garter snake were also present in this area and frequently captured at these hibernacula.

In southwestern Saskatchewan, the occurrence of Prairie Rattlesnakes appears to be limited to the Frenchman River Valley from Val Marie southeast to the Montana border. Historical records of rattlesnake sightings outside of this area were not substantiated by our surveys, although the possibility of rattlesnakes occurring within the proposed East Block of Grasslands National Park cannot be ruled out. Poor weather and difficult access prevented a thorough search of the area in 1990. Our searches within the Frenchman River Valley confirmed the continuing existence of the five hibernacula identified as "active" by Mackay in 1987, and led to the discovery of five additional rattlesnake hibernacula and one hibernacula used by several species of colubrid snakes. A total of 236 rattlesnakes was captured and marked, with den population sizes ranging from one to 131. Bullsnakes, the Plains Garter Snake (*Thamnophis radix*), and Eastern Yellow-bellied Racers were also found at hibernacula in this area.

Twenty-three Eastern Yellow-bellied Racers were captured and marked during the 1990/1991 survey of the Frenchman River Valley rattlesnake dens. All of them were found at or near entrances to communal hibernacula. Remains of four other racers were found at one hibernacula, these included two neonates and two adult racers that had been killed and partially consumed by some mammal (Badgers [*Taxidea taxus*], Striped Skunks [*Mephitis mephitis*], or other mustelids) and by raptors (Swainson's Hawk [*Buteo swainsoni*]). Eastern Yellow-bellied Racers were seen or captured at nine of 10 hibernacula in the Frenchman River Valley during 1990/1991, whereas Mackay (1987) observed racers at just two of the five dens in the same area.

Most of the hibernacula in the province are found on Crown land used for grazing and eight of the 12 dens near Leader are on lands already designated under the Critical Wildlife Habitat Protection Act (CWHPA). Of the twelve snake dens in the south, 11 are on land that is either presently within, or soon will be within, the proposed boundaries of Grasslands National Park. About one-half of the hibernacula had received some amount of human visitation, as evident by the presence of garbage, shotgun shells, damage to den entrances, etc. Acts of deliberate killing of rattlesnakes were documented by Mackay at a den near Val Marie in 1987. We learned of recent attempts to kill rattlesnakes and destroy dens with flammable materials at two hibernacula in the Leader area. These appeared to be isolated events carried out by misguided individuals and did not reflect the general attitude of residents in either area. As far as we can determine, there has not been any commercial harvesting of rattlesnakes in the province.

Life-History Parameters Of Prairie Rattlesnakes

Growth

Since snakes generally do not have external markers of age, it is often very difficult to accurately age snakes on the basis of size, especially when growth rates are unknown. In rattlesnakes, a new rattle segment is added to the base of the existing string of rattles each time the snake undergoes ecdysis (sheds). Therefore, the number of segments on the rattles is a potential indicator of age if the rattle string is intact and the frequency of ecdysis is known. Recapture of marked snakes over one growing season can provide information on growth and frequency of ecdysis; unfortunately, large numbers of snakes must be marked in order to obtain even a handful of recaptures.

In our studies we recaptured a few adult rattlesnakes, none of which showed any measurable growth during the interval. We suspect that most yearling rattlesnakes may shed one to three times and assumed that on average they shed twice per annum until adult size (about 800 mm SVL) is attained. Adults appear to shed just once during the active season.

An approximate growth curve was generated based on mean SVL of juveniles in rattle size classes for the northern population (Figure 2). Growth data for the southern population is very similar. Based on a shedding frequency outlined above the average rattlesnake would attain an adult size of about 800 mm SVL during it's fourth growing season.

Reproduction

The smallest female Prairie Rattlesnake that contained enlarged follicles or embryos was 785 mm SVL and had seven rattles plus the button (7+B). According to the growth curve, this female was mated either during the end of her third or fourth growing season and would deliver her litter at the end of her fourth or fifth year. Other females would not likely mature at

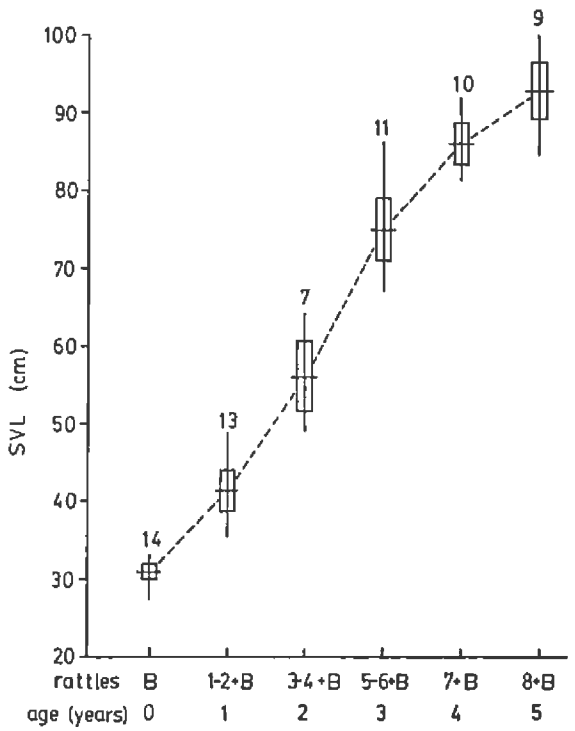

Figure 2. Growth curve for juvenile Prairie Rattlesnakes (sexes pooled) in the northern population, based on body size distribution in rattle size classes. Approximate age classes corresponding to each rattle class is also shown. Horizontal line = mean SVL, vertical line = SVL range, rectangle = 2 S.E.

this early an age. Enlarged follicles were seldom palpated in females less than 840 mm SVL thus it is probable the majority of females would attain sexual maturation at four or five years and produce their first litter in the fall of their fifth or sixth year.

Mean litter size based on abdominal palpation of enlarged follicles or embryos in gravid females in the southern population was 10.2 (SE = 0.8, n = 25, range = 8 - 16 young) and in the northern population it was 8.2 (SE = 0.3, n = 30, range = 4 - 11). There are reliable reports of litters of 20 to 30 young born in captivity to some large females from the Frenchman River Valley (Lise Perrault, pers. comm.).

Timing of parturition is likely to vary slightly from year-to-year and among individuals. In Saskatchewan post-parturient females and neonates are encountered in late August and early September. The mean size of neonate rattlesnakes based on measurements of neonates captured shortly after parturition was 260 mm SVL for the southern population (SE = 2.3, n = 49, range 215 - 280 mm) and 308 mm (SE = 4.3, n = 14, range 270 - 335) in the northern population. There was no sexual-size dimorphism at birth in either population.

Reproductive frequency is best determined by following reproductive histories of individual females over several years, but in short-term studies this is not possible. Another approach is to examine the ratio of gravid to non-gravid females in a population. A 1:1 ratio suggests a reproductive cycle that is at least biennial, i.e., a litter every other year (Macartney and Gregory 1988). We pooled data for mature females (SVL 830 mm SVL, n = 40) from the southern population and calculated the ratio of gravid: non-gravid females to be 0.6:1. For the northern population the same ratio was 0.7:1 (n = 31 adult females). Thus we have a cycle that is at least biennial in these populations. Whether all females in these populations reproduce this often will be influenced by their ability to recuperate body reserves during the non-gravid year. Multi-year mark-recapture studies are needed to verify reproductive frequency; however, we suspect that biennial or triennial reproductive cycles are the most common for female rattlesnakes in Saskatchewan.

Population Composition

Because of low numbers of snakes captured at most den sites, demographic characteristics were analyzed using data pooled for individuals from all dens. Population structure based on spring and autumn sampling included a large proportion of neonates, low numbers of yearlings, an increasing numbers of subadults, and a predominance of adults (Figures 3 and 4).

Another biological parameter illustrated in these figures is that male rattlesnakes generally attain a larger adult size than female rattlesnakes. The largest male was 1350 mm SVL while the largest female was 1194 mm SVL. The sex ratio in the southern population was 1.5:1, males:females (n = 236) in the northern population the ratio was 1:1.1 males:females (n = 130).

The population composition recorded by Mackay at the five dens in the Frenchman River Valley in 1987 differed somewhat from our 1990/1991 study. In general, however, hibernacula that were used by many snakes in 1987, continued to support relatively large populations in 1990/1991, whereas dens at which few snakes were found in 1987 also had few snakes in 1990/91.

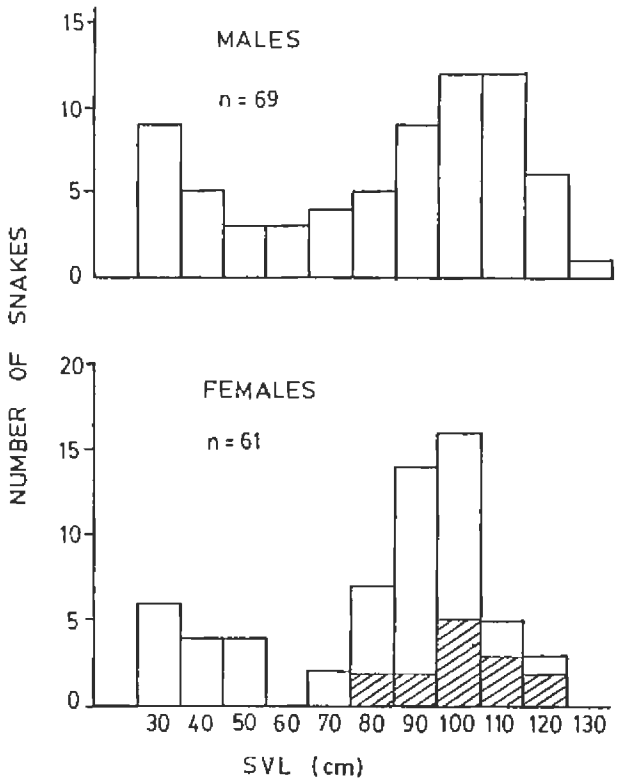

Figure 3. Size-frequency histograms for the northern Prairie Rattlesnake population in Saskatchewan. SVL = snout-vent length and hatched areas represent females with enlarged follicles in autumn sample.

Provincial Population Size

Estimating the number of Prairie Rattlesnakes in Saskatchewan is a difficult task. Doubtless we have not located all the hibernacula in the province, so any estimate based on the known hibernacula is likely to be very inaccurate and at best a conservative estimate. In our 1988 study we applied a factor of 6 multiplied by the number of captured snakes at a den in order estimate total den populations. This factor was derived from data obtained during a similar, but longer term, mark-recapture study on the Northern Pacific Rattlesnake (*Crotalus viridis oreganus*) in British Columbia, in which over a three year period up to 95% of rattlesnakes at given dens were marked (Macartney 1985). On average, population size estimates based on the Jolly-Seber method at these dens were six times higher than the numbers of snakes that were captured during the first spring in which these dens were sampled. We are really just extrapolating to compensate for the fact that we had relatively little time to sample at any of the Saskatchewan dens (1 to 6 visits per den).

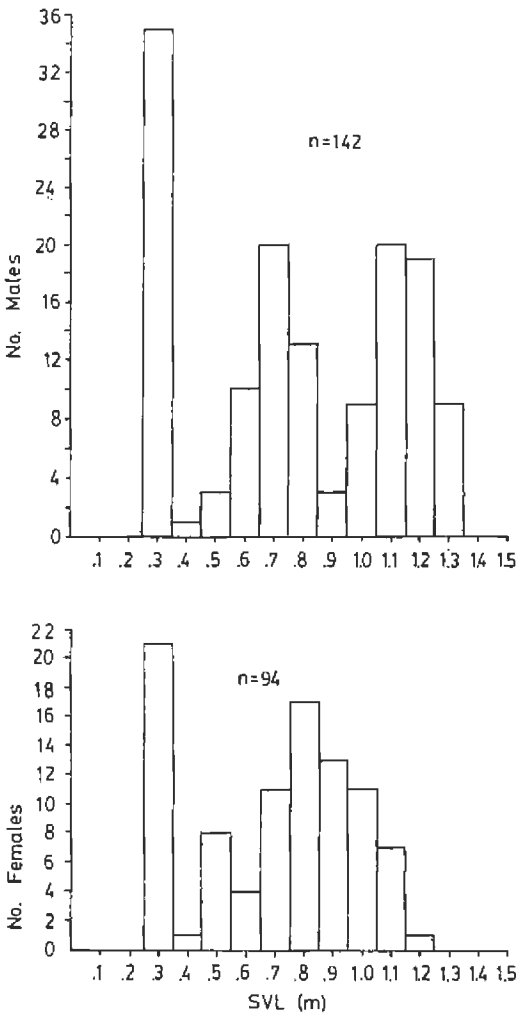

Figure 4. Size-frequency histograms for the southern Prairie Rattlesnake population in Saskatchewan. SVL = snout-vent length.

If we apply this correction factor to the total number of snakes marked at all dens in the province an estimate of about 2200 rattlesnakes is obtained. We can probably easily double this figure to compensate for the suspected number of dens we have not found. Thus a conservative range for the size of the Prairie Rattlesnake population in Saskatchewan is 2000 to 4500 individual snakes.

Life-History Parameters of the Eastern Yellow-bellied Racer

There is currently no information to indicate that the racer exists anywhere in Saskatchewan except for the

two river valleys mentioned above (Didiuk 1986). Both Mackay's 1987 study and the present study suggest that densities may be quite low, with less than 10 individual snakes using a given den. However, racers also hibernated at sites other than those used by rattlesnakes and there likely are many other denning sites in the Frenchman River Valley that are used by racers. The continued existence of the Big Muddy area population has not be confirmed for over a decade.

Racers are oviparous, laying small clutches of eggs in June or July that hatch in August or September. Neonates are between 230 to 250 mm SVL. They have a distinct, mottled reddish-brown dorsal colour pattern, resembling young Bullsnakes more so than the solid greenish-blue colour pattern of adult racers. The ventral surface of neonate and juvenile racers is pale yellow with an orange spot on the lateral margins of each ventral scute. The dorsal patches and the ventral orange spots fade as snakes mature and are absent in adults.

We captured one neonate (230 mm SVL) and a small racer (445 mm SVL) with a distinct juvenile pattern that was probably one year old. Three somewhat larger racers (515, 585, and 610 mm SVL) had adult dorsal colouration and yet retained juvenile ventral spots. These snakes were likely in their second year of growth. All racers 615 mm SVL had adult colouration and pattern. If the loss of juvenile markings signifies attainment of sexual maturity, then racers in Saskatchewan probably mature during their third year.

Data we collected during this study were not sufficient to make accurate comments about demography of racer populations. A size frequency histogram is presented in Figure 5. The sex ratio based on the small sample of snakes was 1.3 male: 1 female.

DISCUSSION

Significance Of Demography

The results of this study revealed many similarities in life-history parameters between the northern and southern populations of the Prairie Rattlesnake in Saskatchewan. In general, there is close agreement in terms of growth rates and age at sexual maturity and first reproduction, and in maximum body size measurements. Biennial or triennial reproductive cycles are likely present in both populations. The average litter size of 10.2 young was greater than the mean of 8.2 calculated for the northern sub-population. However, a

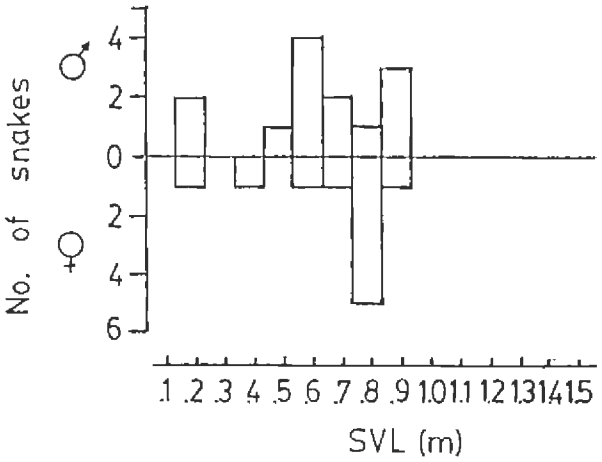

Figure 5. Size-frequency histogram for the Eastern Yellow-bellied Racer population marked in the Frenchman River Valley, Saskatchewan.

greater SVL range of females was sampled in the latter sub-population and thus smaller females with correspondingly smaller litters (there is a direct, although not a strong, correlation between body size and litter size in rattlesnakes) would tend to have lowered the estimated average litter size.

The size-frequency histograms for the northern and southern sub-populations showed similar patterns of population structure. These populations are dominated by subadults and adults and appear to have moderately high annual recruitment of neonates. In both populations juvenile snakes are under-represented. These histograms illustrate a practically universal feature of rattlesnake populations in general: very poor neonatal and juvenile survivorship (Macartney 1985, Parker and Plummer 1987). The near absence of juveniles at hibernacula may suggest that juveniles may hibernate in sites other than their natal den or it may also reflect the fact that juveniles are more cryptic and harder to find and capture at dens than adults, and their under representation is a sampling artifact. Studies on more intensely sampled populations of the Northern Pacific Rattlesnake in British Columbia, suggest that the lack of juveniles is due to very low annual survivorship of neonates and yearling rattlesnakes and not due to sampling difficulties (Macartney 1985).

The combined effects of relatively slow growth and late sexual maturation, infrequent reproduction, small litter size, and poor juvenile survivorship result in populations that are very slow to increase size or change in composition, i.e., they are relatively stable

over long periods of time. The stability occurs because annual survivorship of adults is high and because rattlesnakes are fairly long-lived animals (estimated age of large adult Northern Pacific Rattlesnakes is greater than 20 years (Macartney et al. 1990), thus a stable core of adult snakes serves as a buffer during those years when reproduction or juvenile survivorship is particularly poor.

The fact that we noted little change in the relative numbers of snakes at the five dens in the Frenchman River Valley after a three year hiatus is consistent with the population dynamics described above, i.e., any noticeable change in population size or composition is likely to occur very gradually.

Rattlesnake populations are most susceptible to catastrophic events such as large-scale illegal harvesting and alterations to hibernacula (natural or man-made) since these may rapidly and drastically reduce the size and alter the composition of populations. Furthermore, Prairie Rattlesnake dens in the Frenchman River valley and along the South Saskatchewan River are widely separated and neighbouring den populations would provide very minor sources of recruitment through emigration. Therefore, if adult snakes are preferentially removed from the population as occurs when rattlesnake hunters seek "trophy" sized animals or their parts, then it will require an even longer period for the number of reproductive mature females to build back up in the population and for their offspring to then enter the adult population. Following such an event, a period of several decades may be necessary for the den populations to recover to former levels.

To date, the principle recognized threat to rattlesnakes has been human disturbance at dens. Malicious hunting/slaughter of snakes at dens has been documented for both populations in Saskatchewan the recent past. In our experience, there are usually one or two dens whose locations are known to most persons living in a given region. These sites tend to be the most readily accessible and therefore, receive the brunt of the visitation by the curious and are most likely to be the target of misguided individuals who wish to harm snakes or dens. These sites also tend to be more frequently monitored by concerned individuals or agencies responsible for protecting rattlesnakes or their hibernating sites, therefore, acts of vandalism are more likely to be recorded when they occur at these sites.

Most of the hibernacula in Saskatchewan are on lands leased for grazing cattle. Stocking densities of livestock are low and vegetation is sparse around most dens, so they do not "attract" increase usage by cattle. Overgrazing and trampling of soils and vegetation near denning areas may affect soil stability around dens, but we found no evidence that this is a significant problem at hibernacula. Some degree of soil erosion causing the partial occlusion of den entrance ways after heavy summer rains seems to be common at many of the dens. Whether this reflects normal soil erosion processes for these areas or is the effect of overgrazing near dens is not known.

The affect that farming practices (e.g., cereal crop production) has had on the quality of foraging habitat for rattlesnakes is largely unknown, but we do know that in both the northern and southern populations, den sites are often closely situated to cultivated fields and that snakes sometime make lengthy migrations away from the dens into or through these areas. Cereal crop production, when compared to undisturbed upland or valley floor prairie grassland habitat, may provide lower quality habitat for snakes to forage in because the homogeneity of the vegetation may reduce the numbers and diversity of small mammals and birds that make up the bulk of the rattlesnake's diet. There is also some incidental mortality of snakes on roads (and possibly in fields during crop harvest).

Like the Prairie Rattlesnake, the main potential threats to Eastern Yellow-bellied Racer populations are loss of habitat (especially denning areas) and direct human hunting/collecting of racers. Road mortality is an easily recognized cause of mortality but is likely to be insignificant compared to mortality from natural predation.

At present, there is no solid evidence to suggest that Prairie Rattlesnake and Eastern Yellow-bellied Racer populations are declining in this province. The 1990/1991 survey discovered more hibernacula and snakes of both species than have ever been collected or observed in previous history for this province. This means little because surveys of this intensity had not been conducted before. These species have probably never been very common or widespread in this province and their occurrence in remote, largely uninhabited, and inaccessible areas has probably meant that populations have been largely undisturbed during historical times.

Since these species have been legally protected from hunting since 1988, the main focus of protection should now be placed on the hibernacula since these

figure prominently in the life-history of snakes and because they are not a readily renewable resource. The remoteness and inaccessibility of most hibernating sites has probably been the main reason why a majority of rattlesnake dens have not been disturbed and will continue to receive little human disturbance. What we don't know and should probably be addressing in the future is the question of how large an area around a den needs to be available to snakes in order for them to continue to survive in these areas? Telemetry studies may prove very helpful in finding out where snakes disperse to during summer months and whether agricultural practices have any effect on dispersal patterns, foraging success, and predation.

Finally, our main management recommendations for conserving these species are that there should be: 1) ongoing annual monitoring of known dens, 2) encouragement of landowners and grazing lessees to report rattlesnake and racer sightings, 3) incentives for these individuals to protect against the malicious hunting of rattlesnakes or damage to hibernacula on their property, 4) public education in communities situated in rattlesnake country, 5) designation under the CWHPA for all quarter sections on which snake hibernacula are present, and 6) that individuals who are found to have altered dens so as to make them unusable by rattlesnakes or racers should be charged under both the CWHPA and the Wildlife Act.

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THE CARBERRY SANDHILLS OF SOUTHWESTERN MANITOBA; THE NEED FOR ACTIVE MANAGEMENT

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INTRODUCTION

Over a 30 year period, while studying the Northern Prairie Skink (*Eumeces s. septentrionalis*) and other interesting members of the Carberry Sandhills ecosystem, it became apparent to me that relationships between plant communities were changing. The most notable change was the rate at which the native mixed grass prairie, and spruce-prairie associations were disappearing. Initially, I noticed small, sucker patches of aspen appearing in low, moist hollows. These patches quickly began to spread. Small clonal bluffs grew larger, and in places merged into the beginnings of a forest. In the 1970s, I became alarmed at the number and size of Leafy Spurge (*Euphorbia esula*) patches east of Canadian Forces Base (CFB) Shilo. Today, most areas of both the military range at Shilo and Spruce Woods Provincial Park glow a distinctive yellow-green in early spring, the color of this noxious weed.

Beginning in 1981, while conducting a study on the status of the Northern Prairie Skink for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), I began to look at the factors affecting the mixed grasslands where the skinks occur.

Many variables affect the succession of one plant community to another. A major factor is the moisture condition, where dry periods favour grasslands and wet periods favor the aspen woodlands. There is a constant tension between the two communities, yet, if left unchecked, Aspen (*Populus tremuloides*) will eventually cover the grassland. While looking closely at vulnerable species such as the Northern Prairie Skink, I observed the rapidly shrinking boundaries of one of the last major remnants of native mixed grass prairie.

HABITAT

The Carberry Sandhills were formed some 12,000 years ago when the Assiniboine River, swollen with glacial melt water, poured into Glacial Lake Agassiz forming the Upper Assiniboine Delta. In places these Ice Age deltaic deposits are 60 to 80 m deep. Following the recession of the Wisconsin ice sheet and drainage and reduction in size of Lake Agassiz, the sands of the delta lay exposed. Strong winds tossed up massive dunes over an area of some 1770 km^2. Slowly, the shifting sands were stabilized with vegetation.

Ritchie (1966), in analyzing pollen from core samples spanning 12,500 years, found the initial dominant vegetation in the area to have been White Spruce (*Picea glauca*) with grasslands. It is only in recent times that pollen records show a deciduous forest influence. Today this spruce-grassland flora remains as a last vestige of the Ice Age, a relict of past glacial times without equal in Canada.

Ehrlich et al. (1957) gives this description of the Carberry Sandhills: "The topography is very gently undulating except in areas of duned sand. The dunes are intermixed longitudinal and crescent shaped and have sharp faces which generally face north and east. Soil drainage is good to excessive. The native vegetation on the very gently undulating topography is intermixed grassland and aspen-oak woods. On the sand dunes the vegetation varies with position and exposure. The north and east facing slopes are favourable regeneration sites for trees and are covered with Aspen, Bur Oak (*Quercus macrocarpa*), and White Spruce. The tops of the dunes are covered by occasional spruce with an undergrowth of ground cedar and mixed prairie grasses. On the south and west slopes, mixed grasses and herbs are the predominant vegetation." Scoggan (1953) notes that the Sandhills is one of the few sites in the province where true prairie flora is preserved.

Soil-type is the major limiting factor in the Manitoba distribution of skinks. They require an open surface cover of mixed grass prairie, yet it is the loose, sandy soil that allows them to easily burrow well below the frostline in winter (Bredin 1981, 1989).

THE NORTHERN PRAIRIE SKINK

The Northern Prairie Skink is a member of the lizard family *Scincidae*. This family is widespread, occurring throughout temperate and tropical regions of the

world. The most recent estimate of 86 genera and 1275 species (Haliday and Adler 1986) ranks it as the largest lizard family.

The genus *Eumeces* is widely distributed in both the old and new worlds and contains 46 (Dowling and Duellman 1973) or 35 species (Smith and Brodie 1982), 12 of which occur in North America, three of these ranging northward into Canada (Cook 1984). The Northern Prairie Skink is found in Canada only in southwestern Manitoba. It is the sole skink species in the prairie provinces; one species occurs in Ontario and one in British Columbia.

In common with other small skinks, *Eumeces septentrionalis* is cylindrical, cigar-shaped with relatively small legs. It is olive to olive-brown above, dark on the sides, with seven longitudinal light stripes, the dorsal three often obscure, particularly in mature males. Adults are 130 to 206 mm in total length. The tail is bright blue in hatchlings but fades to steel grey in adults. Mature males develop a deep reddish orange on the sides of the head and throat during the breeding season.

The Northern Prairie Skink is the most unique member of Manitoba's herpetofauna. The small, isolated population of this small lizard in Manitoba is cut off from the continuous range, which reaches its northern apex in Minnesota and southeastern North Dakota. Its distribution is from southwestern Manitoba to the Gulf Coast of Texas; east to western Wisconsin, western and central Iowa and barely into western Arkansas and Louisiana; west to southeastern North Dakota, eastern South Dakota, central Kansas, Oklahoma, and eastern Texas.

The earliest documentation of this skink in Manitoba was a watercolor by Norman Criddle dated May, 23 1898. Correct identification (Patch 1934) did not come until a Manitoba specimen collected by Talbot Criddle from "Aweme" July 2, 1929 was forwarded to the National Museum of Canada by Norman Criddle.

The distribution of the skink in southwestern Manitoba (Figure 1), its life history and related data (Table 1) is well documented (Bredin 1981, 1988a, 1988b, 1989). This information was gathered by marking, releasing, and re-capturing individuals at two study locations, one on the CFB Shilo ranges and one on Crown land just west of Carberry. The Shilo study area produced 74 marked skinks from 11 different sites, the Carberry study area has produced, to date, 91 skinks from six different sites.

Habitat essential to the Northern Prairie Skink constitutes the portions of native mixed grass prairie and associated forbs remaining in the Carberry Sandhills. The most favoured locations are south and west facing slopes. Skinks are not found in areas of tree cover, nor are they found in association with Leafy Spurge.

Succession from prairie to aspen parkland is resulting in a continued loss of open prairie essential to the skink. That, combined with the rapid spread of Leafy Spurge over existing native prairie, poses a serious threat to this species.

Because of its restricted range, geographic disjunction, and dependence on a restricted habitat, the Northern Prairie Skink has been given the status vulnerable in Manitoba. A large portion of its range lies within areas already protected by their designations as Provincial Park, Forest Reserve, Military Area, Crown lands, etc., that preserves essential habitat from development. The skink has never been commercially exploited and can be collected only under permit as provided by provincial regulations. However, the possible

Table 1. The annual cycle of the Northern Prairie Skink in Manitoba.Table 1.

Activity	Earliest Date	Average Date
1) Emergence from hibernation	April 18	May 5-10
2) Males showing breeding color	May 1	May 10-18
3) Peak breeding season (gestation 40 days)		May 25-30
4) Females laying eggs (average clutch 8 eggs)	June 20	July 2-8
5) Appearance of hatchlings (incubation 35 days)	July 21	August 4-8
6) latest sighting		September 9

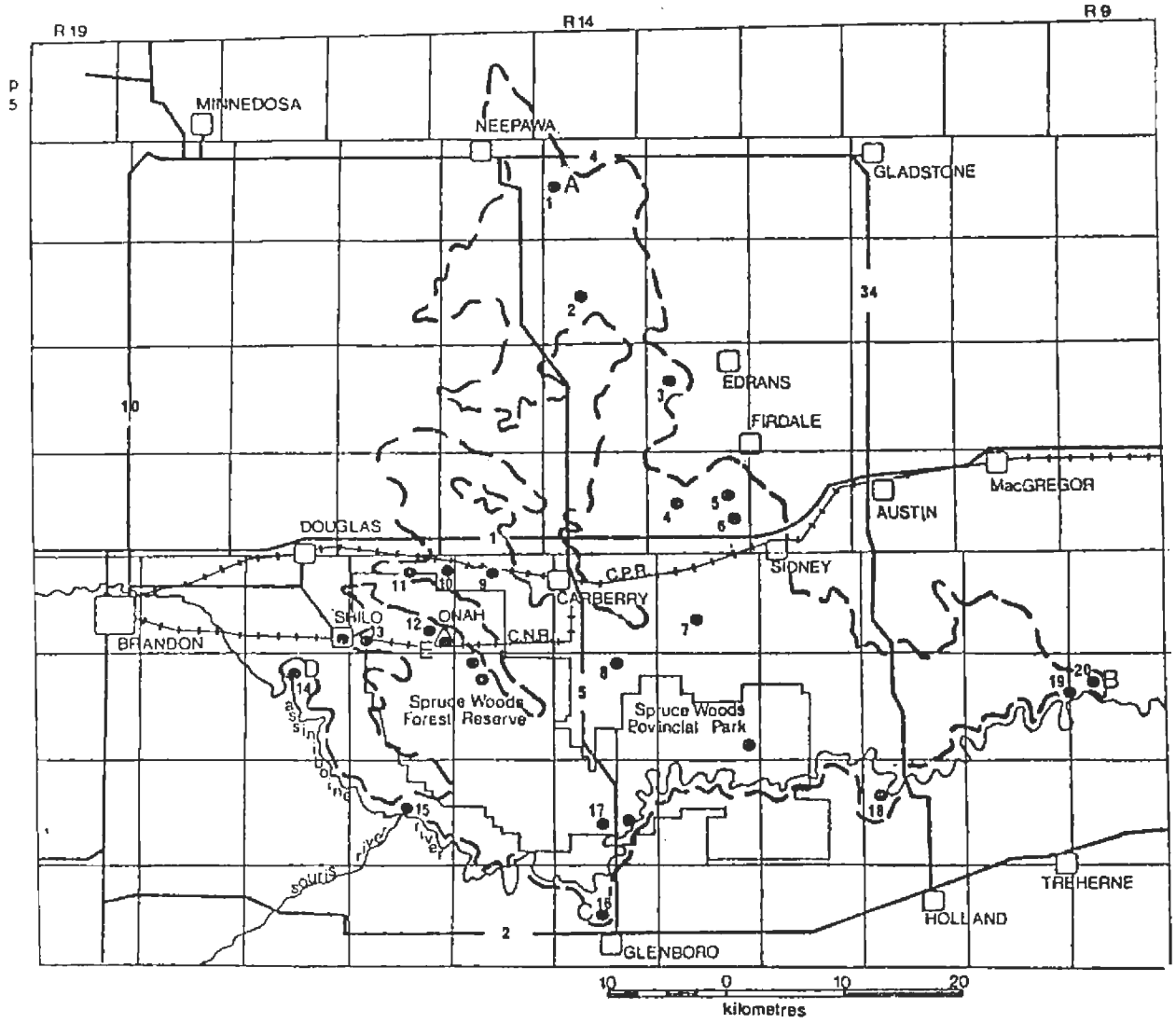

Figure 1. Map of southern Manitoba showing the extent of sandy soils of the Upper Assiniboine Delta region (dashed line) and localities where Northern Prairie Skinks have been recorded (solid circles).

continued invasion of prairie habitat by aspen woodland and the unchecked spread of Leafy Spurge in the area may cause significant detrimental modification of essential aspects of its habitat. If population declines coinciding with such habitat alternations are subsequently documented, consideration of a revision to threatened status could quickly become necessary.

Succession of Mixed Grassland to Aspen Woodland

Since the period of settlement 1870 to 1900, when pioneers invaded southwestern Manitoba, there has been a rapid change in the prairie landscape. Much of the virgin grassland has been lost to domestic crop cultivation. Some areas were not suitable for agricultural use and it is these small remnants that are now priceless and must be managed.

Because of the light, sandy soil and the marked ridges, the Carberry Sandhills were left untouched by early settlers. With the leasing of a large tract of land to the Department of National Defence and later, the establishment of Spruce Woods Provincial Park, large portions of the Sandhills remain untouched by human developments. Yet, being left so, there is as dramatic a change occurring as if these lands had been opened with the plow. These changes are taking place primarily on

unused portions of the Shilo ranges and throughout Spruce Woods Park.

Ernest Thompson Seton, world renowned naturalist and Carberry resident for several years, was, in 1884, concerned at how quickly aspen growth was invading native grassland. Ehrlich et al. (1957), in commenting on the Carberry Sandbills, states: "Aspen is the most prevalent species, ranging from small groves invading the grassland through larger and irregular clumps to closed woodland stands." Nero (1976), in an article on the Sandhills mentions: "Some people have suggested that the area be maintained in a natural state but this is not an easy matter. Ecological succession in the absence of fire favors trembling aspen, this tree species now dominates much of the area closing in on the spruce and overriding the prairie grasslands. Should the area come under management for wildlife and scenic values, some use of controlled fire would probably be necessary. Ecologists maintain that the large number of accidental fires within the CFB Shilo military reservation (in Spruce Woods Provincial Forest) has been beneficial in keeping the forest open and attractive to big game."

When travelling through the Carberry Sandhills, a marked variation is seen. In the active range area of CFB Shilo, there occurs wide expanses of open, undulating grassland. Tbe topography is dotted here and there with clumps of White Spruce. It is a striking landscape without aspen groves. The shrubs and big game flourishes along with species such as the skink, and other rare flora and fauna of the grassland. Each year, exploding shells set off grass fires that burn off expanses of prairie. The result is a viable, healthy grassland.

As one travels away from the active military range, aspen groves thicken and the ratio of grassland to aspen woodland reverses itself. There are only small clearings of native prairie.

Other rare flora and fauna associated with the native prairie and the "open dune" habitat near Spruce Woods Park include: the Loggerhead Shrike (*Lanius ludovicianus*), Baird's Sparrow (*Ammodramus bairdii*), Cooper's Hawk (*Accipiter cooperii*), Upland Sandpiper (*Bartramia longicauda*), Eastern Bluebird (*Sialia sialis*), Sprague's Pipit (*Anthus spragueii*), Chestnut-collared Longspur (*Calcarius ornatus*), Rufous-sided Towhees (*Pipilo erythrophthalmus*), Brown Thrashers (*Toxostoma rufum*), Olive-backed Pocket Mouse (*Perognathus fasciatus*), Northern Grasshopper Mouse (*Onychomys leucogaster*), Tooth Field Grasshopper Tiger (family *Cicindelidae*), and Goldsmith Beetles (family *Crysamiladae*). Grouse leks occur on the higher quality open prairie.

The prairie is dominated by such grasses as: Blue Grama (*Bouteloua gracilis*), Spear Grass (*Stipa comata*), June Grass (*Koeleria macrantha*), Green Needle Grass (*Stipa viridula*), Awned Wheat Grass (*Agropyron trachycaulum*), Sand Grass (*Calamovilfa longifolia*), Canada Wild Rye (*Elymus canadensis*), and Little Bluestem (*Andropogon scoparius*). Other important native prairie plants include Prairie Sagewort (*Artemisia ludoviciana*), Pasture Sagewort (*A. frigida*), Prairie Crocus (*Anemone patens*), Three Flowered Avens (*Geum triflorum*), Spike Moss (*Selaginella densa*), Dotted Blazing Star (*Liatris punctata*), Prairie Onion (*Allium textile*), Beautiful Sunflower (*Helianthus subrhomboideus*), Purple Prairie Clover (*Petalostemon purpureum*), Owl-clover (*Orthocarpus luteus*), Sand Cherry (*Prunus pumila*), Low Goldenrod (*Solidago missouriensis*), Golden Aster (*Heterotheca villosa*), Many Flowered Aster (*Aster ericoides*), Smooth Aster (*Aster laevis*), and Common Wild Rose (*Rosa woodsii*).

The constant encroachment of aspen and the spread of Leafy Spurge threatens the aforementioned species and all of the more common inhabitants of the prairie ecosystem.

Leafy Spurge

Leafy Spurge is a dicotyledonous, herbaceous, deep rooted perennial of the spurge, *Euphorbiaceae* family. The most conspicuous features of the plant are the yellowish-green flower-like clusters borne on umbels at the tip of the stem. Each stalk can produce from 25 to 150 seeds. It is allelopathic in nature (Galitz and Davis 1983) and apparently suppresses growth and development of otber plant species around it. It has been demonstrated (Letourneau et al. 1956, Selleck et al. 1962) that components of various aqueous and organic solvent extracts from Leafy Spurge suppress germination and seedling growth in other plant species.

Calvin G. Messersmith, Professor of Agronomy, North Dakota State University, in personal communication, writes: "Those of us who work with Leafy Spurge see it spread rather quickly, i.e., big changes over three to five years. The estimated acreage in North Dakota has increased from 423,000 acres in

1973 to 1.2 million acres in 1987. All it takes is one plant to start a new patch and patches more than a few months old are difficult to eradicate."

Leafy Spurge is an introduced species from Europe, first observed in North America at Newbury, Massachusetts in 1827. It was first noted in Manitoba on a farm near Rounthwaite in 1900 by Norman Criddle (Bird 1961). In 1950, the Manitoba Weeds Commission surveyed the CFB Shilo range area and counted 1435 separate patches.

It is one of the first plants to emerge in spring. In my study area it was the first plant species to show signs of growth. Spring growth was detected by April 2, and by April 19, shoots were up 8 cm and by April 22, patches showed shoot development of 11-12 cm. By April 27, flower clusters were forming on umbels.

Once established in a satisfactory location the normal movement of skinks consists of short forays radiating out from a piece of surface cover. Research has indicated these forays seldom exceeds two metres in any direction. During the breeding season young males are inclined to wander further a field in search of females. Indications are that this transitory movement is around the parameters of an established population. Under normal conditions there is never a wholesale relocation of a given population. It appears to only occur when Leafy Spurge invades the site of an established population or when a spreading poplar grove creeps into the immediate area.

In the early 1980s I became increasingly alarmed with the amount of Leafy Spurge showing up throughout the Sandhills. Initially, my concern was that large open expanses of mixed grassland were being entirely taken over by this weed and other, native plant species were being eliminated. The impact of Leafy Spurge on the Northern Prairie Skink began to show itself through concentrated field work beginning in 1983. From 1978 to 1983, I recorded a wholesale movement of skinks from one area where a patch of Leafy Spurge had begun to establish itself to another location offering reduced cover. The spurge quickly covered the entire south-facing ridge where marked skinks had been located. These marked individuals were being recaptured up to 60 m away from the point of first capture and for skinks this is a very significant move.

This prompted further study and I visited other areas where skinks had been sighted through the years. In three locations, existing populations of skinks had disappeared with the appearance of Leafy Spurge. It is perhaps the loss of natural cover along with a reduction of available food that forces skinks to relocate when spurge moves in.

Chemical control of this plant is neither feasible nor desirable in the Carberry Sandhills. The cost of such a program is prohibitive; more importantly, many rare and endangered broadleaf species of native flora would be killed.

There is an effort being funded by the Department of National Defence for the biological control of Leafy Spurge. This appears to be the most practical alternative for control of this weed. Because of its genetic diversity some feel that at least four to six spurge destroying insect species and/or diseases will have to be established for a biological control program to be successful.

CONCLUSION

The objective of this third Workshop includes how to implement World Wildlife Fund (WWF) Canada's Prairie Conservation Action Plan (PCAP) and to encourage recovery efforts for species in jeopardy. The PCAP (WWF 1988, page 4) states, "Loss of habitat is the most critical issue for wildlife. The potential for species extinctions iu the prairies is a matter of serious concern." The Shilo Military Range in Manitoba is one of the largest aspen parkland areas left in Canada. Under the heading: "Aspen Parkland Ecoregion," the PCAP recommends (page 14): "cooperative conservation efforts between the DND and the Manitoba Department of Natural Resources should be maintained to ensure protection of the flora and fauna in the Shilo area."

Initiatives to implement effective aud active management of this threatened, limited resource have been taken by the Department of National Defence (DND), but no such measures currently exist for Spruce Woods Park. There is a grave irony in all this. Manitoba Natural Resources - Parks issued a bulletin in July 1989 titled "Public Consultation on a Management Plan for Spruce Woods Provincial Heritage Park." It mentions the park is a natural treasure and goes on to state: "One of the most outstanding provincial parks in the system. It will take the best possible management plan to guarantee that the park continues to offer its remarkable recreational activities to Manitobans and visitors to the province."

A final park management plan was to he in place by Decemher 1990, instead it's on indefinite hold. Apparently a "sustainable development" paper will be coming out this year (1992) on all parks in the provincial system. This is meaningless in regard to Spruce Woods. It only allows the deterioration, and succession to continue—a year makes a difference.

I say this out of deep concern because the DND is taking positive steps to manage the portion of the Sandhills they control. The military has played and continues to play a significant role in conserving Manitoba's native prairie heritage. An Environmental Protection Plan will be drafted for the military ranges this year and it is my sincere hope that Manitoha Parks takes a look at it and implements a similar plan for Spruce Woods Provincial Park.

Hind (1859), Seton (1909), Criddle (1911), Scoggan (1953), Ehrlich et al. (1957), Bird (1961), Nero (1976), all discuss a loss of native prairie and give reasons why. I have talked with local residents who recall a time around the turn of the century when there was hardly an aspen to be seen and no Leafy Spurge. Over the past 30 years I have watched the prairie disappear, not lost to cultivation, but lost to mis-management.

Before the influx of settlers, the control of the prairie fires and the elimination of the Plains Bison (*Bison b. bison*), the grasslands were doing just fine. So little native prairie is left. To set aside, as a park, such fragile habitat and feel that the grasslands, aspen woodland, and other important plant communities will coexist in harmonious equilibrium is foolhardy.

My association with the Carberry Sandhills began as a child. It was a wilderness full of adventure. As I matured, my interests did also, I observed the "hills" with scientific interest. I now feel a relationship with this land that transcends the disciplines of science, it speaks to me in ways words cannot describe—on the one hand a child-like wonder for its beauty and mystery, on the other, a profound agony, a sense of loss.

I end by quoting from the PCAP: "Living things are an important part of the world we live in—they impart not only economically and scientifically useful resources, but also much in the way of beauty, inspiration, recreation, cultural and spiritual value. They affect our quality of life, and help define who we are as Westerners and Canadians."

"In short, if we want wildlife (species), a healthy environment (ecosystems), and the economic benefits that flow from them, then we must act now to conserve native prairie and wildlife habitat. To lose any more will mean losing it all."

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REPTILES SESSION SUMMARY

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SESSION SUMMARY

The materials covered in this session were collected as labours of love. Any of the speakers could have used the entire time available. The audience was more than willing to listen and learn but there was little opportunity for session discussion. Since so few people knew anything about the species involved, this lack of discussion may have been appropriate for this first such session.

The reptiles considered (Short-horned Lizard [*Phrynosoma douglassi*], Prairie Rattlesnake [*Crotalus viridis*], Eastern Yellow-bellied Racer [*Coluber constrictor flaviventris*], Western Hognose Snake [*Heterodon nasicus*], and Northern Prairie Skink [*Eumeces s. septentrionalis*]) all face similar human development problems. All the species live in extremely small areas. Skinks and lizards may spend their entire lives only metres from their birth places. This survival technique has two major flaws when human developments are involved. First, disturbance or successional changes over small areas will result in population losses because local residents will not shift their territories. Secondly, roads, cultivation, irrigated farmlands, and access routes through their habitats will result in dividing the populations causing local extirpations. In either case, environmental changes will result in vacant habitats that will only slowly be recolonized.

Habitat management is essential for all reptile species considered if they are to remain in their traditional locations. Before management plans can be instituted, more information is needed on species biology and essential habitat needs. The effects of habitat disjunction, dispersal mechanisms, and reintroduction potentials all need to be clarified before management can be successful. For example, can grassland reptiles be successfully reintroduced? Are animals released outside their territories sentenced to death? Can habitat be created for these species?

Reproductive potential is very low for all species discussed. In the case of Prairie Rattlesnakes, females likely give birth every two or three years. All the species are vulnerable to vandalism because they are slow moving, concentrate at annually used locations at predictable times, and generally lack appreciation by humans. All are in decline and will require special consideration to maintain viable populations throughout their Canadian breeding ranges.

Speakers at the next workshop should be well aware that the purpose of the meeting is to discuss potentially effective management for the species involved and not to describe the biology of the animal. The number of speakers should be reduced or the session lengthened to accommodate the discussion aspect of the workshop. In the workshop interval, considerable data needs to be collected so that enough information is available for management discussions to be meaningful.

MONITORING SONGBIRDS IN THE PRAIRIE PROVINCES

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INTRODUCTION

There is an increasing body of evidence that long-distance migrant birds have declined (Askins et al. 1990, Gauthreaux 1990, Hussell et al. 1990, Robbins et al. 1989, Stewart 1987). Some point to deforestation in the tropics as the main factor in the decline (Morton 1980, Rappole et al. 1983, Briggs and Criswell 1986), others point to forest fragmentation on the breeding grounds with consequential increases in nest predation and cowbird parasitism (Lynch and Whitcomb 1978, Butcher et al. 1981, Brittingham and Temple 1983). Rappole and Powell (1986) and Terborgh (1989) argue that while the proximate problems may be on the breeding grounds, the ultimate limitation will soon switch to the wintering grounds. Diamond (1986, 1991) provides the only quantified estimates of losses through tropical deforestation of winter habitat to Canadian long-distance migrants.

A classical but outmoded concept is that forest wildlife are dependent on the forest for their existence, but that forests can exist without wildlife. Increasing evidence suggests, however, that forests and their wildlife are co-dependent and intricately inter-related as a result of a long co-evolution. One of the more striking examples of this co-dependence was postulated by Holling (1988), who suggested that tropical deforestation, the decline of long-distance migrant birds (those species that breed in temperate zones but winter in the tropics), and the recent "unexpected behaviour" of the Spruce Budworm (*Choristoneura fumiferana*), particularly in eastern North America, may be related phenomena.

The connection between the decline of long-distance migrants and outbreaks of budworms is at present speculative, but surely warrants investigation. Under normal conditions, budworm outbreaks follow a cyclical pattern that is moderated to some extent by its predators. Holling suggested that when numbers of predators were reduced, the cycles would become more erratic; outbreaks would be more severe and occur more frequently. Holmes (1990) reviewed the impacts of bird predation on forest insects, and concluded that "birds...exert through their foraging activities important influences in (forest) communities on both ecological and evolutionary time scales."

It has long been known that songbirds are important predators on budworms. Some bird species are generalists which prey on budworms only opportunistically; others are specialists whose numbers and distribution appear to be directly related to budworm outbreaks. Among the specialists are several Paruline warblers, including the Tennessee (*Vermivora peregrina*), Cape May (*Dendroica tigrina*), and Bay-breasted Warblers (*D. castanea*) of the western boreal forest.

Recent evidence from Breeding Bird Surveys (BBS) from the eastern United States and Canada (as analyzed by Robbins et al. 1989) has shown that the numbers of many species of long-distance migrant birds have declined substantially between 1978 and 1987. Among the species whose numbers have declined the most severely are Bay-breasted (down by 15.8%, $p < 0.01$) and Tennessee Warblers (down by 11.6%, $p < 0.05$).

There has not yet been evidence of declines in long-distance migrants breeding in the forests of the prairie provinces. However, recent resurveys of forest bird monitoring plots near Doré Lake, Saskatchewan (Canadian Wildlife Service [CWS], unpublished data) (Table 1); and comparisons across several decades of numbers banded during fall migration through the prairies (Table 2), suggest strongly that the Tennessee Warbler has undergone a considerable reduction in its numbers in the western boreal forest. While numbers of Tennessee Warblers do fluctuate considerably in relation to Spruce Budworm cycles, budworm infestation was high in the Doré Lake area in 1990 and 1991, which should have led to high populations of Tennessee Warblers there, so the birds' decline is likely real. Population trends among forest songbirds may therefore prove to be of real economic interest to foresters, in addition to their implications for those charged with the conservation of migratory birds.

Table 1. Number of Tennessee Warbler Territories per 100 hectares on four plots surveyed at Doré Lake, Saskatchewan, 1973 and 1990/1991 (CWS, unpublished data). 1973 surveys by A.J. Erskine, 1990/1991 by P. Chytyk; both analyzed by D. Kirk.

Plot	Habitat Type/Location	1973	1990/91
1.	Mature Birch and Poplar Forest Michel point	80	2
2.	Balsam Fir Forest Appleby Bay, Sled Lake	63	46
3.	Black Spruce with Alder Swales Doré Lake Airstrip	74	46
4.	Young Aspen Forest Mirasty Lake	74	23
Average		73	29

The Role of Migration Monitoring Stations

Because relatively little study has been directed toward the details of migration in prairie neotropical migrants, and because only a coordinated research program which examines all phases of the migratory circuit can determine the stage or stages of the annual cycle during which declines may be taking place, it is essential that efforts be directed towards this phase of their life cycle, as much as to breeding and wintering biology and habitat needs.

Dawson (1990) pointed out that migration monitoring data "could be useful in corroborating trends estimated for species using data from the BBS or the Christmas Bird Count and in estimating trends for species that are not well sampled by these monitoring techniques." Hussell et al. (1990) have already shown a statistically significant correlation between BBS results for Ontario and the fall migration through Long Point. Migration monitoring may be the only way of censusing species such as the Blackpoll Warbler (*Dendroica striata*) and Gray-cheeked Thrush (*Catharus minimus*) whose breeding ranges lie in remote and uninhabited regions.

Dawson (1990) adds that "migration banding data offer two additional potential uses: 1) to monitor trends of adults returning from wintering grounds, and 2) to monitor trends in the number of adults and young surviving the breeding season. For species with declining populations, examination of trends from two seasons and for the two age classes might suggest whether the declines are associated with the breeding grounds or the wintering grounds."

While a number of migration monitoring stations (or bird observatories) have been established in eastern and southern North America, few exist in western Canada. Migration monitoring stations strategically located in western Canada may be our best option to

Table 2. Proportion of Tennessee Warblers in total wood warblers (Parulinae) banded in selected locations in Alberta and Saskatchewan.

	Nipawin, SK[1]	Edmonton, AB[2]	Beaverhill Lake, AB[3]	Last Mountain Lake, SK[4]
Years	1955-1960	1957-71	1980-89	1989-91
Tennessee Warblers	2031	1957	400	57
Total Warblers	2636	3455	3513	1935
%Tennessee Warblers	77	57	11	3

[1]Houston and Street 1959; [2]Salt 1973; [3]Jungkind 1989; [4]Smith unpubl. data.

monitor migrants breeding beyond the reach of the BBS and to confirm the results of BBS data.

Changes in the age structure of fall migrants might imply poor reproduction, while changes in the age and sex structure of spring migrants might indicate that on the wintering grounds there is sex or age-related segregation by geographic area or habitat, and that changes in habitat quality or quantity may be affecting age/sex ratios. Changes in physical condition of the birds might indicate changes in the quality of the breeding range (fall migrants) or wintering range (spring migrants).

Other related information from migrants can also be of value. Weight gains, for example, can indicate the flight ranges of the birds captured (see Nisbet et al. 1963, and below), or may reflect changes in quality of habitat at the migration stop-overs, and wing-lengths can shed light on the geographic origin of birds (Raveling 1965, Raveling and Warner 1978).

Another reason to study migrant songbirds is to improve knowledge of their migration physiology. Studies at Last Mountain Lake Bird Banding Station (Saskatchewan) have yielded new information on the importance of migration stopovers to migrating songbirds. In 1990, for example, we found that Blackpoll Warblers migrating through the Last Mountain Lake area remained for an average of 3.4 (± 1.0) days, and gained 0.44 (± 0.3) grams for each day they stayed. We know that a bird the size of a Blackpoll Warbler can fly one hour for each .08 g. of mass gained (Nisbet et al. 1963), and that their air speed is about 40 kph (22 knots). With the prevailing winds in the northern Great Plains often at 30 kph and often from the northwest, this translates into ground speeds of around 70 kph. Since Blackpoll Warblers at Last Mountain Lake gain on average 1.5 g while there, their next flight should last about 19 hours (1.5 g/.08 g per hour). A ground speed of 70 kph and a southeasterly flight path would take our Blackpoll Warblers some 1300 km and put them in the northern Illinois/southern Iowa area of the American Midwest. In still air, with a ground speed of 40 kph, they would fly about 760 km, reaching around the North Dakota - Minnesota border. This suggests that Last Mountain Lake is more than a mere rest stop but serves also as a refuelling station, at least for Blackpoll Warblers.

In summary, we suggest that monitoring migrant songbirds as they pass through the prairies can make a significant contribution to their conservation, by measuring annual productivity, and possibly survival and population trends as well, in addition to providing essential information on habitat needs of these birds on migration.

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SONGBIRD MIGRATION AT BEAVERHILL LAKE, 1980 TO 1991

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INTRODUCTION

With the present widespread concern over possible declines in neotropical migratory songbirds due to forest fragmentation and destruction on both breeding and wintering grounds, a network of songbird migration monitoring stations is being proposed for prairie Canada. This paper will present some of the banding results from 12 years of songbird migration monitoring at Beaverhill Lake in an effort to evaluate it's significance as a migratory songbird concentration or stopover site.

STUDY AREA DESCRIPTION

Beaverhill Lake is located about 70 km southeast of Edmonton, Alberta, in the aspen parkland zone. There are large areas of mature woodland 20 km west and northwest of the lake (Cooking Lake moraine uplands and Elk Island National Park) but most of the surrounding region, especially southeast is unwooded and primarily farmland. The lake is bordered to the south and east by strips of young aspen woodland, up to 12 m in height and extending up to 1 km in width, which grade through willow thickets to a strip of open grassland, about 25 to 150 m wide, adjacent to the lakeshore. Periodic flooding and spring melt water bring the lake up to the willow outskirts on occasion.

The Beaverhill Bird Observatory (BBO) Field Station is located 1 km west of a large bay at the southeast corner of the lake and 150 m south of the lakeshore. Net lanes (up to 30) are scattered among the edges and willow thickets interspersed with grassy openings. All lie within 100 m of the Field Station. Most of the net lanes are oriented north-south to intercept east-west movements of birds. Cattle grazing has been prohibited from this area since 1987.

DESCRIPTION OF ACTIVITIES

Bird banding at the BBO site was sporadic and minimal from 1980 to 1983, with two or three days of banding per season at most. With the creation of the BBO in 1984, there was more participation in the banding and a census route was set out. There were still large gaps however, in the banding and censusing activities in 1984 and 1985. From 1986 on, bird banding was maintained every year at a steady pace (at least once in each 10-day period) throughout the main spring and fall migrations. Summer field assistants participated in and expanded the banding and censusing activities in 1987 to 1990. In spite of this, overall effort in bird banding and censusing remained at a low level up until 1989 as manpower and energy were diverted to other more specific projects and activities. A MAPS (Monitoring Avian Productivity and Survivorship) station with constant effort mist netting (De Sante 1991) was set up on the site in 1989, continued in 1990 and 1991, to complement the migration monitoring.

Another individual, Edgar Jones (EJ), has banded with mist nets each year from 1980 to 1991. His capture method is to operate as many nets as possible, all day long for about a week at a time, up to four times a year, during peak spring and fall migration periods.

BANDING RESULTS

From 1980 to 1991, a total of 26,450 birds have been banded at Beaverhill Lake through the separate efforts of the BBO and EJ. At least 22,000 of these were "woodland" songbirds captured with mist nets. Although there were a lot fewer birds banded from 1980 to 1985 than from 1986 to 1991 at both the BBO's and EJs' sites, and there is no net-hour data available for 1980 to 1985, a comparison of the species percentages can give an indication of which species may have increased or decreased relative to the others. In order to eliminate the influences of non-woodland mist netting results, the comparisons in Table 1 are restricted to five major families of woodland passerines: flycatchers, chickadees, *Catharus* thrushes, vireos, and warblers. Capture totals for these species are:

BBO	-	1980-85 - 563 birds banded, 24 sp.
		1986-91 - 4381 birds banded, 34 sp.
EJ	-	1980-85 - 2152 birds banded, 30 sp.
		1986-91 - 8546 birds banded, 33 sp.

Table 1. Percentages of "woodland songbirds" banded from 1980 to 1991 at Beaverhill Lake by the Beaverhill Bird Observatory and Edgar Jones for 10 different species.

	Percentage of birds banded out of flycatchers, chickadees, *Catharus* thrushes, vireos, and warblers in the years:					
	1980-85		1986-91		Change in %	
Species	BBO	EJ	BBO	EJ	BBO	EJ
(Breeding)						
Traill's Flycatcher	4.4	2.7	3.9	2.8	-0.5	0.1
Least Flycatcher	35.7	23.2	27.3	25.6	-8.4	2.4
Black-capped Chickadee	18.1	13.1	6.5	5.5	-11.6	-7.6
Warbling Vireo	3.2	2.0	3.3	1.8	0.1	-0.2
Yellow Warbler	15.5	12.3	19.6	22.1	4.2	9.8
(Transient)						
Tennessee Warbler	1.2	5.1	8.6	3.7	7.3	-1.4
Yellow-rumped Warbler	13.3	30.9	16.5	30.8	3.2	-0.2
Blackpoll Warbler	1.1	1.3	1.7	1.3	0.6	0.0
American Redstart	0.2	1.7	4.0	0.8	3.9	-0.8
Wilson's Warbler	1.8	0.5	1.1	0.4	-0.7	-0.1
All other species from these five families	5.5	7.3	7.4	5.3	1.9	-2.0

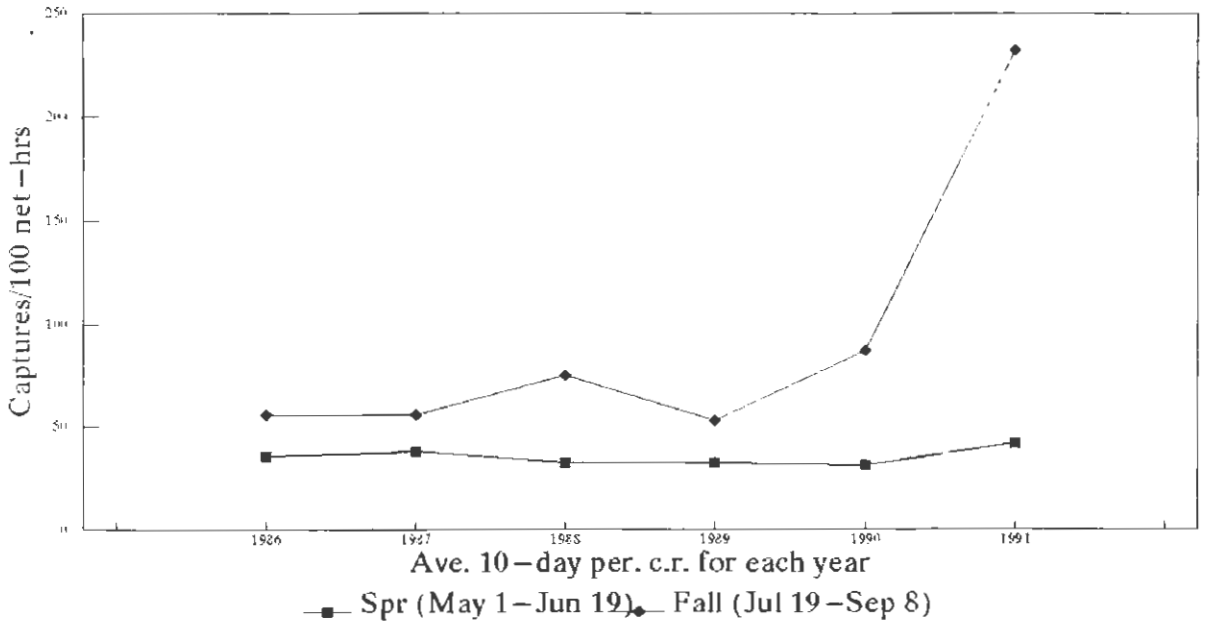

Figure 1. Average spring and fall ten-day period capture rates at the Beaverhill Bird Observatory for 1986 to 1991.

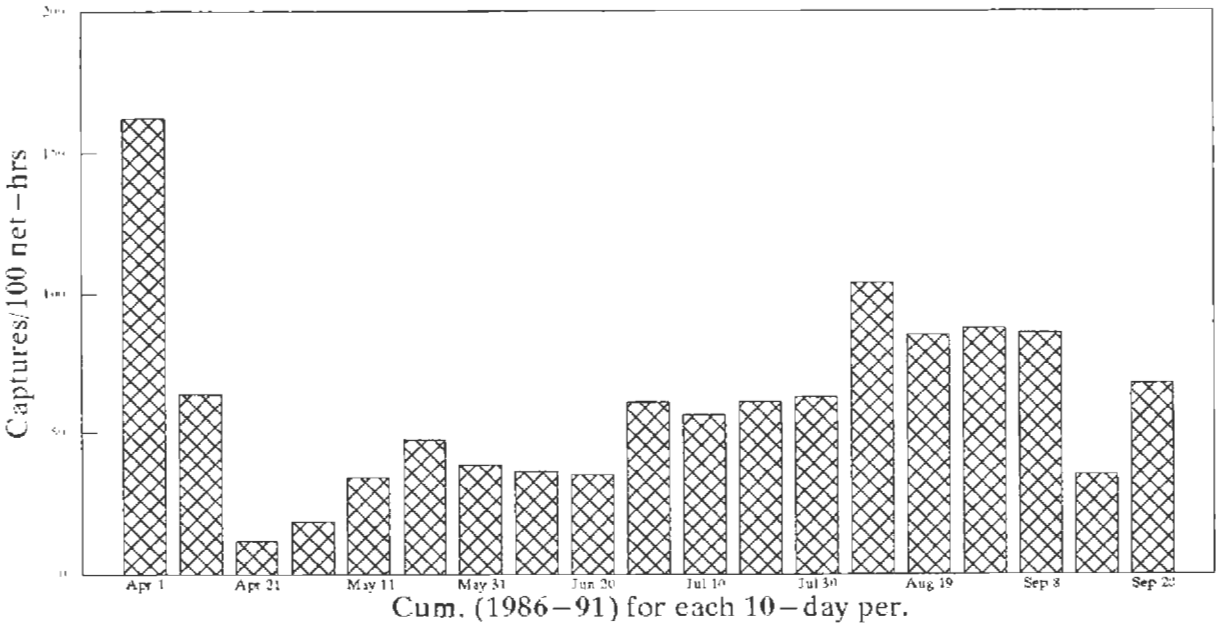

Figure 2. Ten-day period capture rates calculated over six years (1986 to 1991) for April 1 to October 7 at the Beaverhill Bird Observatory.

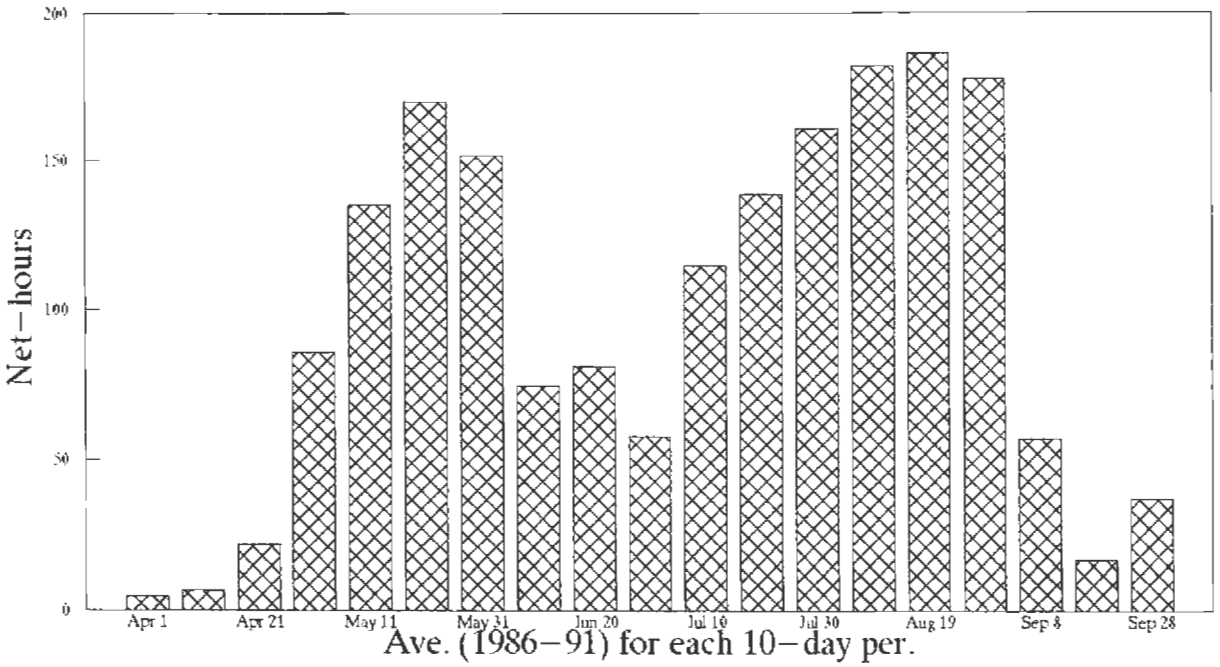

Figure 3. Average (1986 to 1991) ten-day period net hours at the Beaverhill Bird Observatory for April 1 to October 7.

These species make up 70% of the 22,000 woodland songbirds banded. The species selected for the comparisons were the five most banded breeding species and the five most banded transient species. It is interesting to note that while the percentages of four of the transient species of the BBO increased (three of them significantly), the percentages for those same species remained static or decreased in EJs' banding results. This is contrary to what one would expect since the BBO has increased its banding efforts during the breeding season while EJ continues to band only during spring and fall migration. It is possible that lack of grazing at the BBO site since 1987 has had a greater positive impact on transient species than breeding species. The Tennessee Warbler (*Vermivora peregrina*) increase at the BBO site (largest of all migration-only species) contrasts strongly with a major long-term decrease in Tennessee Warbler captures from EJs' bird banding activities in Edmonton prior to the mid 1980s (Jones 1986).

CAPTURE RATES FROM 1986 TO 1991

Since 1986, mist nets have been used at the BBO Field Station site for a total of 11,014.5 net hours (for 1988 to 1991, only "woodland" mist net hours have been included). This has resulted in 6645 captures, out of which 5800 birds of 71 woodland songbird species have been banded, including more than 1200 banded each year since 1989.

The large increases in the average 10-day period spring and fall capture rates from 1989 to 1991, are primarily due to extremely high 10-day period capture rates in August of both years (Figure 1). In 1991 in particular, extremely heavy migration on August 24 and 25 filled the nets to the point where five experienced banders could not keep up with the flood of birds in just two nets. A total of 250 birds were caught over the two mornings.

Mist netting effort has been quite good for the six year period. There are 20 possible mist netting periods (ten days each) between April 1 and October 7 each year. Eleven periods were identical for each of the six years (May 1 to June 19 and July 10 to August 28). In addition, five of six years saw the August 29 to September 8 mist netting period completed, four of six years saw the two periods between January 20 and July 9 completed, and three years of six saw the remaining six periods completed (April 1 to 30 and September 8 to October 7). It is apparent that with the exception of mid-September, maximum mist net effort has been during the most productive 10-day periods (Figure 2 and 3).

The yearly capture rate of 71 birds/100 net hour at the BBO in 1990 (1712.5 net hours and 1216 birds banded) compares favourably with the 66.2 birds/100 net hours recorded at Last Mountain Lake in 1990 (Smith 1991). The capture rate at the BBO for 1991 was 98.2 birds/100 net hours (1667.5 net hours and 1636 birds banded).

Table 2. Comparison between the Beaverhill Bird Observatory and Edgar Jones of capture rates and net hours for bird banding at Beaverhill Lake from 1988 to 1991.

	1988	1989	1990	1991	Average
Net hours					
BBO spr. (May 21-June 9)	273.25	446.6	167	369.68	314.1
EJ spring	1520	569	2896	1181	1541.5
BBO fall (July 21-Sept. 7)	565	1673.85	782.75	646.75	917.1
EJ fall	1686	2894	2223	1856	2164.8
Capture rate					
BBO spr. (May 21-June 9)	47.2	43.3	50.3	38.7	44.9
EJ spring	26.6	46.7	28.1	56.4	39.5
BBO fall (July 21-Sept. 7)	74.7	52.3	105.3	206.1	109.6
EJ fall	58.6	45.2	75.4	215.5	98.7

N.B. - BBO 1990 net hours and capture rate includes Sept. 18-27 to correspond to Edgar Jones' banding periods for that year

In order to compare capture rates to those of EJs' at Beaverhill Lake, it is necessary to restrict the comparison to the peak migration periods in spring (May 11 to June 9) and fall (July 20 to September 7), since those periods are when EJs' bird banding takes place. Both spring and fall peak period capture rates at the BBO are similar to those at EJs' sites (Table 2). The close parallel between the fall capture rates at the two sites over the four years suggest that whatever phenomenon created the huge increase in capture rate at the BBO is not site specific. Table 2 should also clarify why EJ catches so many more birds than the BBO each year—it is not because he is at a better location, but rather that he is able to accomplish more net-hours of mist netting during the most productive time of year.

CAPTURE RATES FOR INDIVIDUAL SPECIES

In order to make year-to-year capture rate comparisons meaningful for individual species, net hours have to be restricted to the 10-day periods during which the species occurs at Beaverhill Lake. This has been done for the same 10 species discussed earlier, using time frames derived from 12 years of sight records and banding data (Figure 4 and 5). All the species except Black-capped Chickadee (*Parus atricapillus*) and Blackpoll Warbler (*Dendroica striata*) had their highest capture rate in 1991, but this is most pronounced in the transient species—especially Yellow-rumped Warbler (*Dendroica coronata*), Tennessee Warbler, and American Redstart (*Setophaga ruticilla*). It is apparent that a large part of the 1990 and 1991 overall capture rate increases were due to the Yellow-rumped Warbler capture rate increases in those years.

RETRAPS

Gathering adequate retrap data on a species usually means there must first be a sufficient number of birds of that species banded. All but one (Swainson's Thrush [*Catharus ustulatus*]) of the top 20 species banded from woodland mist nets at the BBO from 1986 to 1991 have yielded retrap data of some sort (Table 3). The locally breeding species have all yielded "returns" at various percentages (Jungkind 1990, Campbell 1991) but the local nonbreeding species have only yielded one "return" in all the years of banding at the BBO—a Tennessee Warbler banded as after hatch year/male (HY/M) on August 17, 1989 was retrapped on August 27, 1990. However, with "repeats" there are enough records to start considering repeat percentages (Table 4) (see North American Bird Banding Manual for definition of "repeats" and "returns"). The length of stay for some of the locally nonbreeding species individuals certainly gives the impression that the BBO study area may be a major stopover site for songbirds on migration.

There have been 19 individual birds that were captured at both the BBO site and EJs' site—14 Yellow-rumped Warblers, 3 Least Flycatchers (*Empidonax minimus*), one Northern Oriole (*Icterus galbula*), and one Tennessee Warbler. It is interesting to note that all except two (both Yellow-rumped Warblers) of the locally breeding species individuals were caught in different years at the two sites, while all five of the locally nonbreeding species individuals were caught in the same season. The two HY/M Yellow-rumped Warblers that were banded at the BBO in August 1991 and recaptured four days later at EJs' site (about 8 km northeast) are particularly revealing. Perhaps the entire southeast corner and east shore of Beaverhill Lake is being used as a single stopover site by migrating songbirds.

With 10,935 birds banded in total at the BBO since 1980 and only 11 recoveries, our recovery rate of 0.1% is not enviable. However, our only two long distance recoveries from woodland mist netting—a Least Flycatcher recovered in Guatemala and a Yellow-rumped Warbler recovered near Macon, Georgia—have already sparked additional interest and incentive to get more people involved in the bird banding program.

CONCLUSION

Although the data collected so far on songbird migration at Beaverhill Lake is not overwhelming in quantity, considering the length of time it has gone on, the capture rates and numbers of birds banded in 1990 and 1991 in particular seem to indicate that Beaverhill Lake and the BBO Field Station site may be a major songbird migration and stopover location in fall if not in spring also.

The strong points of the activities so far are: 1) six years of consistently spaced mist netting results for long stretches of the spring and fall migration, which will be valuable for comparisons to future years' data; 2) good, detailed experience gained regarding the effectiveness of the different net lanes under various weather conditions and different times of year; and 3) enough birds banded already that repeat, return and recovery data is starting to develop.

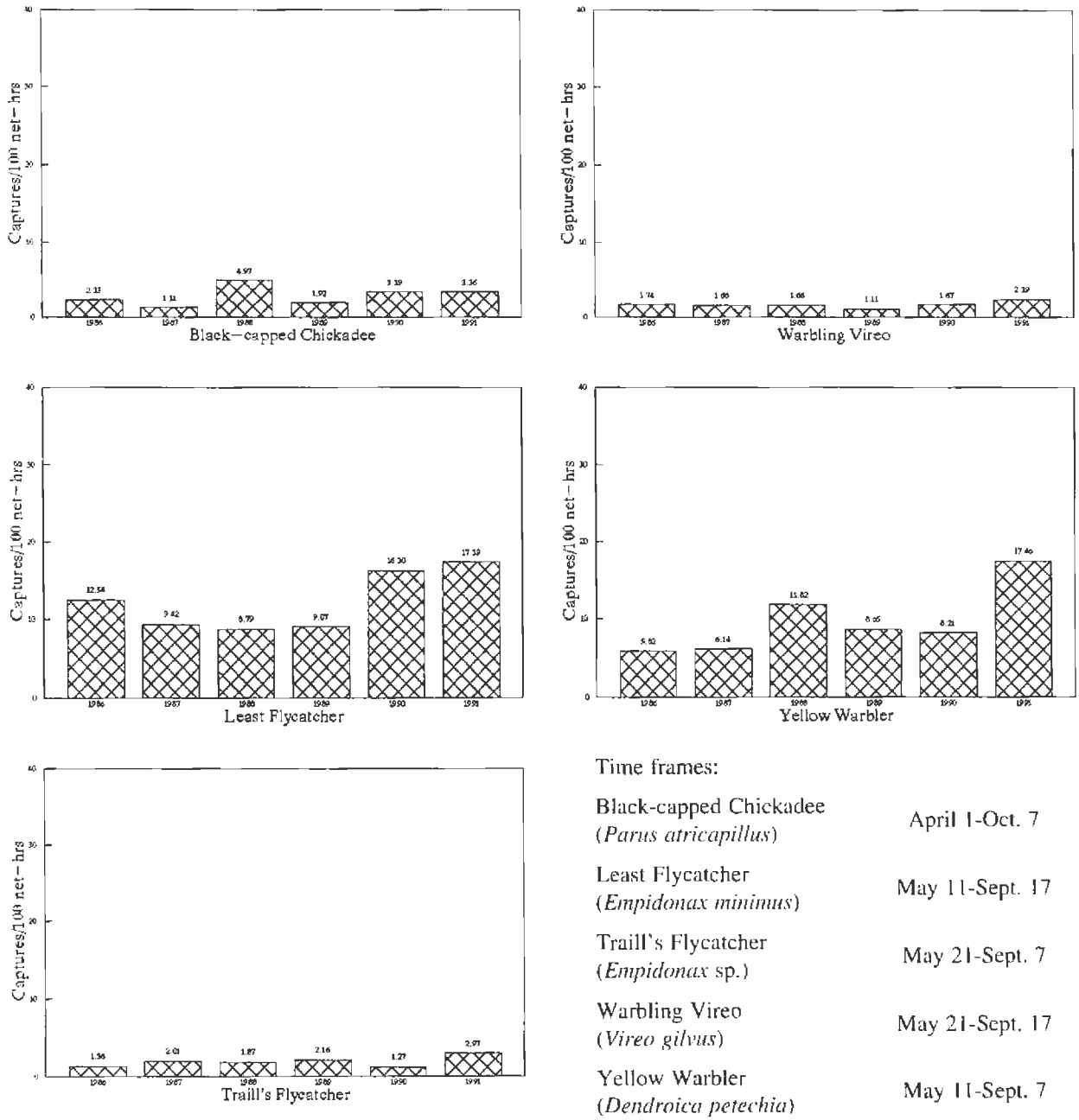

Figure 4. Capture rates from 1986 to 1991 for five breeding species at the Beaverhill Bird Observatory

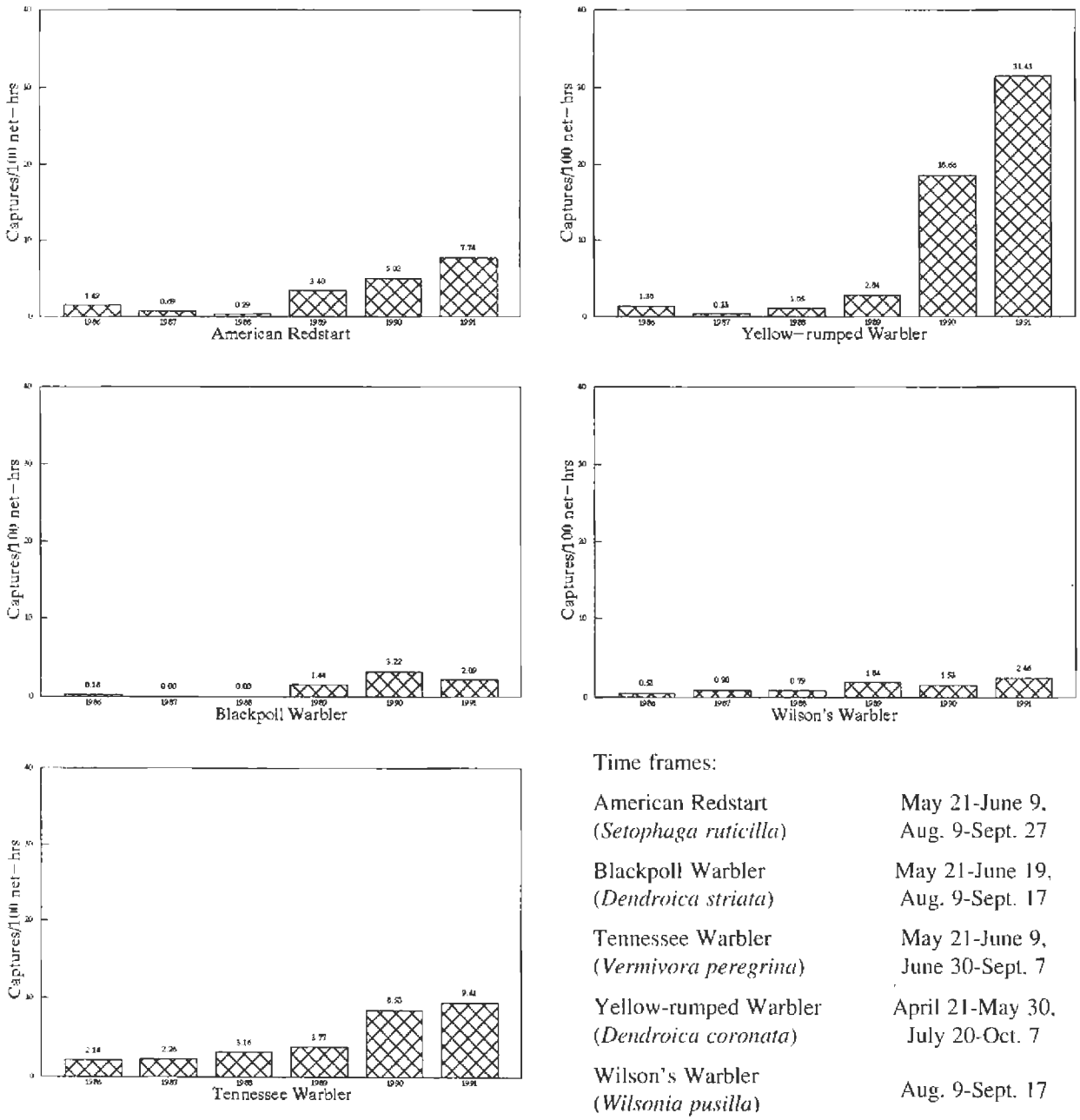

Figure 5. Capture rates from 1986 to 1991 for five transient species at the Beaverhill Bird Observatory.

Table 3. Birds banded from woodland mist net captures at the Beaverhill Bird Observatory, 1986 to 1991 - top 20 species banded.

Species	1986	1987	1988	1989	1990	1991	Total 1986-91
Least Flycatcher (*Empidonax minimus*)	213	110	89	272	252	261	1197
Yellow Warbler (*Dendroica petechia*)	93	68	109	239	106	244	859
Yellow-rumped Warbler (*D. coronata*)	21	3	10	67	231	392	724
Clay-colored Sparrow (*Spizella pallida*)	53	34	37	71	115	194	504
Tennessee Warbler (*Vermivora peregrina*)	29	21	28	99	90	109	376
Black-capped Chickadee (*Parus atricapillus*)	40	17	57	60	53	57	284
American Redstart (*Setophaga ruticilla*)	16	5	2	52	45	57	177
Traill's Flycatcher (*Empidonax* sp.)	19	23	17	60	17	36	172
American Tree Sparrow (*Spizella arborea*)	28	8	31	15	42	40	164
Warbling Vireo (*Vireo gilvus*)	25	19	16	32	25	27	144
Red-winged Blackbird (*Agelaius phoeniceus*)	9	36	36	12	8	10	111
Blackpoll Warbler (*Dendroica striata*)	2	0	0	23	32	17	74
American Goldfinch (*Carduelis tristis*)	26	12	15	5	2	10	70
Savannah Sparrow (*Passerculus sandwichensis*)	11	8	19	15	7	9	69
Northern Oriole (*Icterus galbula*)	8	12	6	8	8	10	52
Brown-headed Cowbird (*Molothrus ater*)	13	0	5	16	9	8	51
Wilson's Warbler (*Wilsonia pusilla*)	4	3	3	19	11	9	49
Magnolia Warbler (*Dendroica magnolia*)	5	2	3	10	20	6	46
Red-eyed Vireo (*Vireo olivaceus*)	6	1	2	9	9	11	38
Swainson's Thrush (*Catharus ustulatus*)	4	0	1	25	2	3	35

Table 4. Repeat totals and percentages for 19 species banded at the Beaverhill Bird Observatory from 1986 to 1991.

	Total repeats 1986-91	Total banded 1986-91	Repeat %	Max. # of days	Length of stay (dates)
Downy Woodpecker (*Picoides pubescens*)	4	20	20.0		
Traill's Flycatcher (*Empidonax* sp.)	7	172	4.1		
Least Flycatcher (*E. minimus*)	82	1197	6.9		
Black-capped Chickadee (*Parus atricapillus*)	113	284	39.8		
Warbling Vireo (*Vireo gilvus*)	10	144	6.9		
Tennessee Warbler* (*Vermivora peregrina*)	14	376	3.7	34	July 20-Aug. 23, 1986
Yellow Warbler (*Dendroica petechia*)	98	859	11.4		
Magnolia Warbler* (*D. magnolia*)	1	46	2.2	2	Aug. 25-27, 1990
Cape May Warbler* (*D. tigrina*)	1	5	20.0	29	July 22-Aug. 20, 1989
Yellow-rumped Warbler* (*D. coronata*)	17	724	2.3	25	Aug. 6-31, 1991
Blackpoll Warbler* (*D. striata*)	2	74	2.7	1	Aug. 30-31, 1990
American Redstart* (*Setophaga ruticilla*)	3	177	1.7	2	Aug. 10-12, 1991
Wilson's Warbler* (*Wilsonia pusilla*)	1	49	2.0	3	Aug. 11-14, 1989
American Tree Sparrow* (*Spizella arborea*)	3	164	1.8	8	Sept. 28-Oct. 6, 1991
Clay-colored Sparrow (*S. pallida*)	43	504	8.5		
Savannah Sparrow (*Passerculus sandwichensis*)	1	69	1.4		
White-crowned Sparrow* (*Zonotrichia leucophrys*)	1	21	4.8	1	Sept. 4-5, 1988
Northern Oriole (*Icterus galbula*)	8	52	15.4		
American Goldfinch (*Carduelis tristis*)	11	70	15.7		

Average for non-breeding spp. (*) 4.6
Average for breeding spp. 13.0

The weak points are: 1) lack of consistent censusing to complement the banding program; 2) too few days of banding out of each 10-day period (usually only two or three) can result in many migration waves being missed; and 3) too wide a variety of data collection practices.

All these weaknesses have been and continue to be tackled, with big improvements showing in 1990 and 1991. Although volunteer effort continues to increase in quantity and quality, a systematic and rigorous approach seems feasible only with participation of employed personnel in the program.

Many questions have arisen while compiling the data presented in this paper: Why the increased capture rates? Is there a connection between transient species increases and lack of grazing? What are directions and destinations of the songbirds passing through? Why are some of them staying so long—moult? putting on fat, etc.? These questions leave us with a great desire to encourage increased quality and quantity of the songbird migration monitoring at the BBO Field Station to the point where there will be a fully operational daily banding and censusing program maintained at the site throughout spring and fall.

ACKNOWLEDGMENTS

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PATTERNS OF MIGRATION OF WARBLERS THROUGH THE DUNE-RIDGE FOREST, DELTA MARSH, 1982 TO 1984: THE NEED FOR A SECOND LOOK

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SUMMARY

Timing of fall migration and patterns of moult of warblers moving through the dune ridge forest at Delta Marsh, Manitoba, were monitored by den Haan and Sealy during 1982 to 1984. Mist netting was conducted almost daily from early June to September and three to five days/week until mid October on a 0.3 km section of the ridge forest, primarily west of the University of Manitoba Field Station (Delta Marsh) on the south shore of Lake Winnipeg in Manitoba. Warblers were aged by "skulling"; permitting hatch year (HY) and after HY designations prior to about mid September. At the end of September, any birds not definitely determined as HY were classified as birds of unknown age (U) because "early season" HY's may have acquired fully-ossified skulls by this time.

During 8,868.1 net hours (July 1 to October 30), 2345 warblers representing 21 species were banded for an overall capture rate of 26.4 warblers per 100 net hours. Tennessee Warblers (*Vermivora peregrina*) were most numerous (n = 607) followed by Yellow-rumped Warblers (*Dendroica coronata*, n = 606), Northern Waterthrush (*Seiurus noveboracensis*, n = 234), American Redstart (*Setophaga ruticilla*, n = 196), Ovenbird (*Seiurus aurocapillus*, n = 134), Orange-crowned Warbler (*Vermivora celata*, n = 93), Blackpoll Warbler (*Dendroica striata*, n = 74), Black-and-white Warbler (*Mniotilta varia*, n = 63), and Nashville Warbler (*Vermivora ruficapilla*). For each of these species, we determined, using contingency analysis based on periods appropriate for each species, how catch rate (captures per net-hour) and age compositions changed over the three years of the study. Significant increases in populations of Tennessee, Nashville, and Yellow-rumped Warblers, Ovenbird, Northern Waterthrush, and American Redstart were found in 1983 compared to 1982 and 1984. A significant increase in the proportion of HYs was found also in 1983 for Tennessee Warblers.

Other species captured were Canada (*Wilsonia canadensis*, n = 44), Connecticut (*Oporornis agilis*, n = 36), Magnolia (*Dendroica magnolia*, n = 35), Palm (*D. palmarum*, n = 33), Mourning (*Oporornis philadelphia*, n = 25), Wilson's (*Wilsonia pusilla*, n = 22), Bay-breasted (*Dendroica castanea*, n = 13), Cape May (*D. tigrina*, n = 8), Chestnut-sided (*D. pensylvanica*, n = 5), Blackburnian (*D. fusca*, n = 3), Black-throated Blue (*D. caerulescens*, n = 1), and Black-throated Green Warblers (*D. virens*, n = 1).

The dune ridge forest study site is a valuable monitoring location for warblers and other neotropical migrants. Our historical data for this site provides a unique opportunity to compare relative populations of these birds through time. This is particularly relevant in light of reported declines in these species throughout North America. A minimum of three years of continued monitoring, using methodology identical to that used during 1982 to 1984, is recommended for the period 1992 to 1994.

STATUS OF THE INTERIOR CANADA TRUMPETER SWAN SUBPOPULATION

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INTRODUCTION

During the last 90 years Trumpeter Swans (*Cygnus buccinator*) breeding in western Canada have made a dramatic comeback. From a small remnant flock of less than 100 swans, there are believed to presently be about 1800 to 2000 trumpeters summering in Canada. Although the proportion of Trumpeter Swans breeding in Canada is still small (13%) relative to the total North American population, and breeding flocks are limited to a small portion of western Canada, it is now classified as a vulnerable migratory bird by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Major management concerns are related to the concentration of breeding and wintering habitats in western North America. In order to determine population status and breeding habitat use, surveys of over 15 separate flocks (Figure 1) in western Canada have been conducted every five years in five provincial jurisdictions. This presentation will review the population status and management concerns related to Trumpeter Swans breeding in Canada.

1990 SURVEY RESULTS

The last range-wide survey of the Interior Canada Subpopulation (ICSP) was conducted in 1990 (McKelvey and Hawkings 1990, Shandruk 1990); detected considerable change and growth since 1985. In the Yukon three major flocks (Itsi, Teslin, and Toobally) were surveyed. The total flock size went from 125 in 1985 to 209 swans in 1990 (Figure 2). This was a 65% increase from 1985 and an annual growth rate "r" of 10.6%. In the Northwest Territories Trumpeter Swans were surveyed in the southwestern Mackenzie District centred around Nahanni National Park Reserve (NNPR), this flock increased from 75 in 1985 to 182 in 1990 this was an increase of 129% with an annual growth rate of 18%. In British Columbia three major flocks (Fort Nelson, Fort St. John, and Dawson Creek) were surveyed. The total flock size went from 108 to 294 in 1990. This was an increase of 172% from 1985 and a calculated annual growth rate of 22%. This exceptional growth rate for the British Columbia flock may be due to an under estimation of the 1985 flock size. In Alberta five major and three small

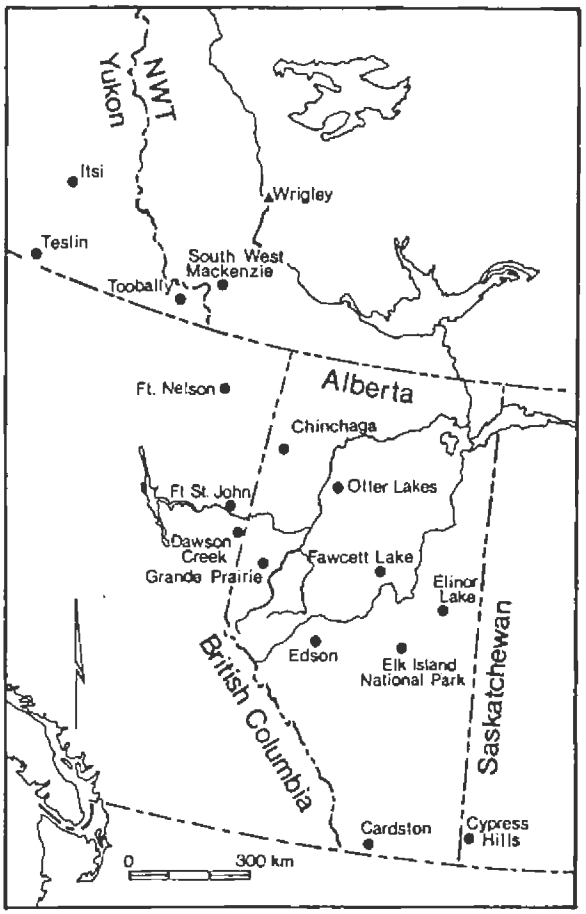

Figure 1. Location of Interior Canada Subpopulation Flocks, 1990.

flocks were surveyed. In general, Alberta flocks increased through the mid-1980s. Grande Prairie has remained relatively stable since then, due in part to winter mortality, spring flooding with consequent poor production, removal of swans to Elk Island National Park (EINP), and possibly immigration to other areas. Several of the smaller flocks have grown significantly since 1985, leading to an overall increase in Alberta's total flock size from 334 observed in 1985 to 477 in 1990. This is a 43% increase in the total population over the five year period and an annual growth rate of 7%. In Saskatchewan only the Cypress Hills flock was

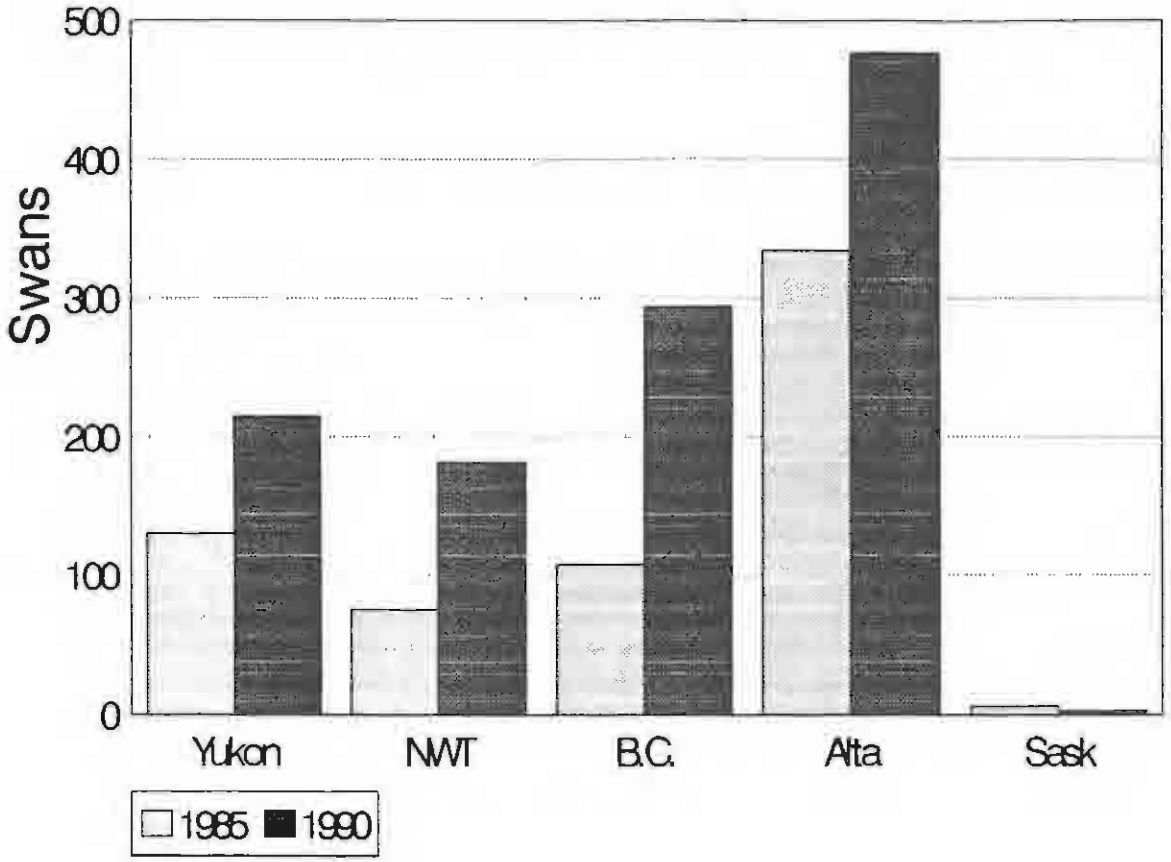

Figure 2. Flock Growth by Province 1985-1990.

surveyed and it continues to decline, with only three trumpeters recorded in 1990 and six in 1985. Without management intervention it will probably not exist in 1995.

Overall within the ICSP total white birds (adults and subadults) increased from 462 in 1985 to 791 in 1990. Cygnet production has increased from 191 in 1985 to 380 in 1990. The total ICSP increased from 653 Trumpeter Swans censused in 1985 to 1171 in 1990, a 79% increase. The results of the 1990 survey also indicate that over the five year period paired swans increased by 82%, flocked swans by 54%, cygnets by 99%, singles by 40%, and broods by 100% (Figure 3). This was an overall growth rate (r) of 12.4% per year. Mean brood size did not show a substantial change going from 3.2 to 3.3 cygnets/brood. The overall productivity for the ICSP (cygnets/total swans) did increase from 29.4% in 1985 to 32.5% in 1990.

EINP

This area was chosen for an experimental program designed to reintroduce an additional breeding flock within historic range, diversify migration patterns, and possibly expand winter range.

In 1987, eight adults and 18 cygnets were relocated from Grand Prairie. Eight adults and 20 cygnets were moved in 1988, followed by 10 adults and 20 cygnets in 1989. In 1990, two adults and 14 cygnets were relocated. In 1991, three adults and four cygnets were relocated from the Grande Prairie area. In addition, four captive reared yearlings were released at EINP.

Winter mortality of relocated trumpeter cygnets has been found to be exceptionally high. Several of the swans transplanted to EINP were observed wintering away from traditional sites in the Tri-state region. At present, five adults are summering at or in the vicinity of the park. Breeding of one pair occurred in 1990 which produced two cygnets which did not fledge.

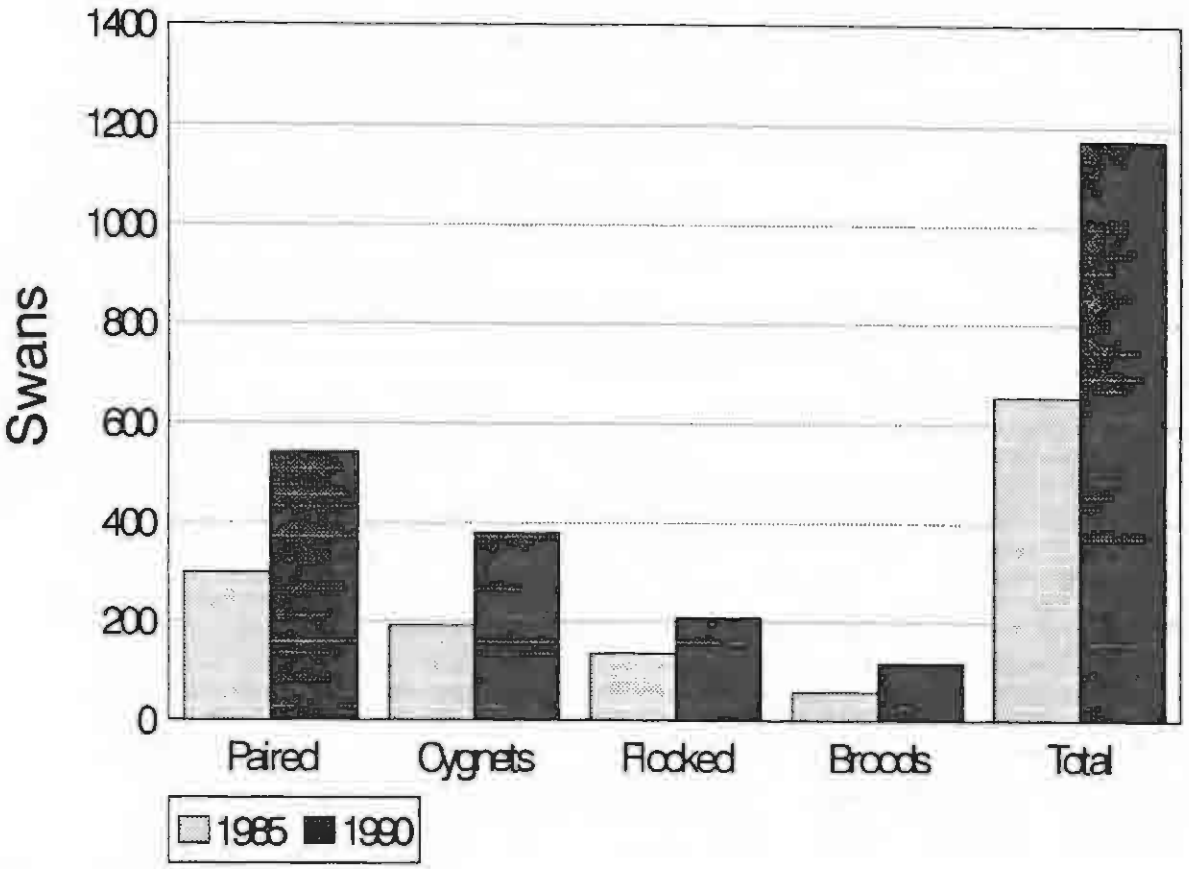

Figure 3. ICSP Flock Component Changes 1985-1990.

The cob of this breeding pair was an original 1987 transplant cygnet, while the female was of unknown origin. But in order for this transplant to succeed, survival and recruitment of relocated trumpeters must be increased.

MIGRATION AND WINTERING

Most of what is known about migrating Canadian Trumpeter Swans comes from observations of birds marked in summer range in Northwest Territories and Alberta, or on winter range in the Tri-state area (Figure 4). Swans begin to leave the northern breeding range in October. Most arrive at various Tri-state wintering sites in late October or early November. Gale et al. (1987) provides a comprehensive review on arrival dates and movements of ICSP swans in the Tri-state area.

Sightings of collared trumpeters during fall migration are somewhat limited. Red collars have been observed at Grande Prairie, at Waterton Lakes National Park, and along the east slope of the Rockies in several locations in Alberta. A red collared swan was observed near Cour d'Alene, Idaho on November 27, 1987.

Most of the swans collared in Alberta winter on or near Yellowstone Lake and River, and Henry's Fork of the Snake River in Idaho. The use of the Henry's Fork with crowded conditions, uncertain access to forage, and extreme winter weather may be impacting ICSP flock growth. Swans migrating from EINP have been seen at numerous winter sites. There are November sightings from Hebgen Lake, Montana; Teton River, Idaho; and Snake River near Rexburg, Idaho; and January sightings from Grand Teton National Park, Wyoming (Shandruk and Winkler 1988). Marked EINP swans have been seen every month from November through April at Red Rock Lakes National Wildlife Refuge (RRLNWR), Montana.

Most swans collared in Northwest Territories appear to winter in the Teton Basin of Idaho. Northwest Territories swans have also been sighted at Wells and

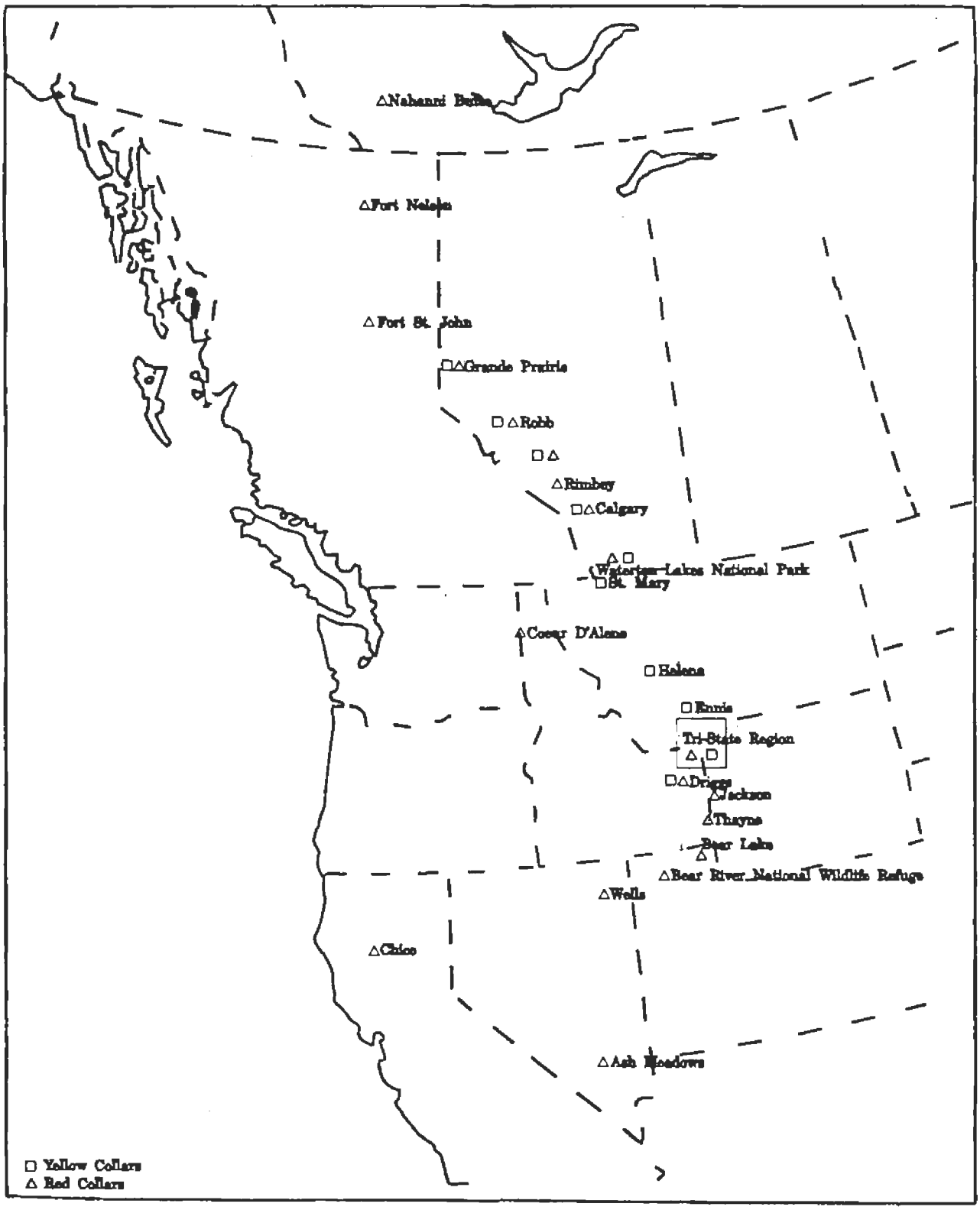

Figure 4. Canadian Collar Observations 1987-1990.

Ash Meadows, Nevada; south central Oregon, and Chico, California.

Trumpeters (green collars) marked during the winter of 1990/1991 have provided considerable information on spring staging and migration. Swans stage at RRL-NWR and Ennis Lake, Montana in February and March. Swans enroute to Canada have been observed in Montana at RRLNWR, Ennis Lake, Lake Helena, and Freezeout Lake. Another smaller migratory route apparently runs from the Tri-state region up the Clark Fork, Bitterroot, and Flathead valleys, with marked swans observed at Warm Springs Wildlife Management Area, Lee Metcalf National Wildlife Refuge, and near Fortine, Montana. In Canada, a majority of green collars were observed in the Cardston-Mountain View area and along the east slopes of the Rockies in Alberta and British Columbia. Scattered sightings also occurred in the Columbia Trench on the west side of the Rockies in Kootenay National Park, British Columbia and the Yukon Territory. Summering green collar trumpeters were observed at Mountain View, Alberta; Rocky Mountain House, Alberta; EINP, Alberta; Edson, Alberta; Grande Prairie, Alberta; Peace River, Alberta; Stoney Lake, British Columbia; and in the NNPR in the Northwest Territories.

MANAGEMENT CONCERNS

It is obvious that the ICSP continues to grow and expand it's breeding range. This growth and expansion has been particularly evident in the northern flocks of the Yukon, Northwest Territories, and British Columbia. In the southern portion of its range, the growth of the ICSP (especially the Grande Prairie flock) has not been as vigorous. Collar observations have indicated that Grande Prairie trumpeters may be major occupants of the over crowded wintering habitats centred on the Henry's Fork of the Snake River. Whereas collar observations of Northwest Territories trumpeters indicate that these birds are more diverse in their choice and use of wintering habitats. This lack of specific dependence upon the Henry's Fork may have enabled the more northern flocks to continue to grow while the southern flocks (Grande Prairie) have begun to show signs of reaching the saturation point of their current wintering areas. Thus there is an urgent need to expand and diversify the current wintering range of the ICSP. Should this not be accomplished immediately, we may lose or reduce the growth of a substantial portion of Trumpeter Swans breeding in Canada. In addition, the growth of the ICSP and their over utilization of the winter habitat is having a negative impact on the growth of the non-migratory Tri-state subpopulation.

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TRUMPETER SWAN SESSION DISCUSSION

Dale G. Hjertaas

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Dale Hjertaas briefly recounted the discovery of a breeding pair of Trumpeter Swans (*Olor buccinator*) near Greenwater Provincial Park in east-central Saskatchewan, bringing the provincial population to two pair. Recent reports from trappers suggest the presence of at least one additional pair in this area. The one pair was collared in 1991 and tracked to the winter area at La Creek National Wildlife Refuge in South Dakota.

Saskatchewan would like to build on this new migration route to develop a migratory population which winters somewhere other than in the crowded Tri-state wintering area. However, managers at La Creek are concerned about over crowding there during the winter and are thus reluctant to see an increased population migrate to La Creek. They apparently wish to encourage some of their swans to migrate further south.

In discussion, the following significant points were raised:

1. All restored populations including those in South Dakota, Minnesota, Michigan, and Wisconsin depend on artificial feeding for their survival.

2. There is concern that many potential over wintering areas are too contaminated with lead shot for use by Trumpeter Swans.

3. Some years ago about 20 juvenile swans were allowed to fly free from their breeding pen at Delta. Some of these swans migrated and returned, the wintering area is not known.

4. The La Creek birds came from Redrock Lake where swans are resident but where migrants also winter.

5. Conflict with hunting seasons on Tundra Swans (*Cygnus columbianus*) in North Dakota is another concern about releasing swans in Saskatchewan.

6. Manitoba is interested in establishing a Trumpeter Swan breeding population, possibly in eastern Manitoba where they would migrate down the Mississippi Flyway and avoid areas of Tundra Swan hunting.

The following suggestions and recommendations were recorded during the session. While not necessarily indicating a consensus there was at least some agreement that these were approaches that should be pursued for Trumpeter Swan restoration in Manitoba and Saskatchewan.

1. Manitoba and Saskatchewan should prepare a joint proposal for swan reintroduction to ensure programs are compatible, show the Americans we are integrated and to work together instead of in competition when seeking sources of birds for release.

2. The winter crowding at La Creek might be dealt with in conjunction with a Saskatchewan release to build on the Greenwater pair. A combination of resource reduction by delaying start up of winter feeding and hazing timed for immediately after the Saskatchewan birds arrive might stimulate the migrants to continue further south. If the pressure at La Creek was substantial they might take some local swans with them. The key would be to reduce the quality of the habitat at La Creek at the appropriate time.

3. To initiate a release where there are currently no Trumpeter Swans, as in Manitoba, it might be possible to just let cygnets go. The one release at Delta suggests that at least some of them will migrate and return, as Canada Geese do. This would leave the young swans to choose their own wintering area but perhaps they understand habitat better than we do anyway.

4. Should ensure that any introduction proposal will produce a self-sustaining population and not one which required continual support.

5. It might be possible to get Trumpeter Swans to migrate with Tundra Swans and so move to safe winter areas.

6. Cygnets from La Creek might be transferred north to build the Greenwater population. They would then migrate back to La Creek. This would have two advantages. It would build the Greenwater population without a net gain in the number at La Creek while increasing the portion of La Creek birds with a tendency to migrate and thus possible move further south.

STATUS OF FERRUGINOUS HAWK AND LOGGERHEAD SHRIKE RECOVERY EFFORTS.

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This presentation will discuss the current status of national recovery plans for the Ferruginous Hawk (*Buteo regalis*) (Schmutz et al. 1990) and the Loggerhead Shrike (*Lanius ludovicianus*) (Telfer 1990), and will outline recovery objectives and regional conservation initiatives. Although measures are being undertaken in each of the prairie provinces, this presentation will focus on conservation efforts and research in Manitoba (within the zone of intergradation between western and eastern subspecies of the Loggerhead Shrike and on the northeastern edge of the breeding range of the Ferruginous Hawk).

FERRUGINOUS HAWK

The Ferruginous Hawk was officially listed as a "threatened" species in Canada during the early 1980s because of substantial reductions in its breeding range and because the species is a food and habitat specialist. Since the Ferruginous Hawk is both a top level predator and a specialist, it is an ideal bio-indicator of the health of prairie ecosystems.

The Ferruginous Hawk National Recovery Team has met on an annual basis to revise the national recovery plan, to priorize national recovery strategies, and to discuss regional management initiatives and future work plans. The national recovery plan lists six recovery actions and priorizes these. The top priority action is to maintain prairie grasslands. Priority II actions include maintaining an adequate prey base for nesting populations, managing nest sites, and perpetuating adequate winter habitat. Priority III actions include preventing human disturbance and shooting, and continued population monitoring. It should be noted that this recovery plan is dynamic (i.e., directions and priorities change over time and as the species responds to conservation actions) and that regional priorities may differ from those presented in the national plan.

The top priority for recovery of Ferruginous Hawks is the maintenance of prairie grasslands (Schmutz et al. 1990). This includes: 1) identifying key nesting habitat and critical areas; 2) managing grasslands for the benefit of Ferruginous Hawks; and 3) conserving existing grasslands.

Conservation of existing grasslands can be accomplished by: 1) encouraging grazing as a sustainable land use; 2) discouraging production of cereal crops on marginal lands; 3) providing incentives to maintain grassland areas; 4) encouraging voluntary stewardship of critical habitats; 5) reinforcing policies that discourage further conversion of public grasslands to cropland; and 6) increasing public awareness of the importance of grassland habitat.

A variety of federal, provincial, municipal, and non-governmental programs include initiatives for land conservation (i.e., the Permanent Cover Program, Farming for Tomorrow, Conservation District initiatives, Prairie CARE [Conservation of Agriculture Resources and the Environment], etc.). Most of these programs subsidize landowners to take marginal lands out of cultivation, to convert cultivated acreage back to forage, or to plant shelterbelts. Since 1987, many critical areas for threatened grassland birds in southwestern Manitoba have been leased or voluntarily protected through cooperative agreements between landowners and the Habitat Heritage Corporation (or its successor, the Critical Wildlife Habitat Program). In 1991 alone, over 2000 acres were protected through this program. The 1991 Threatened Grassland Birds report (de Smet, in prep.) lists other critical areas for these species, including 20 key areas (portions of 70 townships) with suitable habitat to support Ferruginous Hawks.

Maintenance of an adequate prey base essentially involves management of ground squirrel populations. This can be accomplished through: 1) encouraging grazing as a sustainable land use; 2) promoting an understanding of the value and role of ground squirrels; 3) ensuring that poisoning programs do not severely deplete ground squirrel availability in nesting areas; and 4) gaining a better understanding abont the basic biology of ground squirrels and alternate prey sources.

Ground squirrels generally comprise more than three-fourths of the diet of Ferruginous Hawks. Alternate prey items include hares or rabbits (in some western states, they are the primary prey) and Northern Pocket Gophers (*Thomomys talpoides*) (in 1988, one-third of the food remains in Manitoba nests were Northern Pocket Gophers). Promoting the value of ground squirrels to landowners can be a little risky, particularly after these landowners have been overrun with "gophers" as in recent years. Nevertheless, maintenance of ground squirrels may be critical to the survival of Ferruginous Hawks and some other threatened prairie residents (i.e., the Burrowing Owl [*Athene cunicularia*] and Long-tailed Weasel [*Mustela frenata*]).

Management of nest sites includes: 1) locating nests and identifying their conservation needs; 2) encouraging landowners to develop and protect nest sites; 3) fencing used or potential nest sites; 4) planting trees and shelterbelts to create future nest sites; and 5) constructing artificial nests where possible.

Extensive use of artificial nesting structures by Ferruginous Hawks has been one of the most encouraging developments in Manitoba. Grasslands in Manitoba are rarely devoid of trees (as is the case in many potential nesting areas in Alberta and Saskatchewan). Nevertheless, nesting can be encouraged in some areas that are currently unoccupied by situating artificial nest structures in suitable sites. In other areas, nest success can be enhanced by placing structures in more stable trees or in remote locations. Many nests are blown down each year by strong winds. Of 56 nests used in 1990, for example, nearly one quarter had blown down before the 1991 season. Three others were used by Great Horned Owls (*Bubo virginianus*) and two by Red-tailed Hawks (*Buteo jamaicensis*). These Ferruginous Hawk pairs require alternate nests or they will be forced to seek new nesting territories. Data on Manitoba nests reveals that higher nests are generally more successful: 59 nests 8 m in height have produced an average of 2.0 young/initiated nest, compared to 1.6 young/nest for 5 m to 8 m nests (n = 57) and 1.2 young/nest for 59 nests that were lower than 5 m. Since human disturbance often results in abandonment or loss of lower nests, more than half of the 1991 structures were situated at heights of 9 m (30 feet) or more and few were placed lower than 6 m (20 feet).

Two hundred artificial nest structures have been erected in Manitoba since 1987. Although only 12 were used during 1991, this represented one-quarter of the nesting population. Structures that have been provided include a number of wooden platforms, existing magpie or smaller nests that were modified and added onto, and nests that were built from scratch using sticks. Most of the structures in 1990 and 1991 consisted of a basket made from 2 inch stucco wire and filled with sticks. As in the past, these were situated: 1) in a major fork of a tree (generally about two-thirds of the way up); 2) in sturdy trees or branches (often in cottonwoods); 3) in isolated situations (well removed from yards and roads and preferably removed from nearby trees or shrubs); 4) near or within good hunting pastures (with abundant ground squirrels); and 5) in areas where Ferruginous Hawks have previously been seen. Branches are cleared from around the structure and abundant stick material is added to make it more attractive to Ferruginous Hawks and less attractive to other raptors.

Perpetuation of adequate winter habitat presents a management challenge since wintering birds are usually associated with prairie dog (*Cynomys* spp.) colonies. The recovery plan calls for: 1) additional studies of their winter feeding ecology and alternate prey; 2) encouragement of prairie dog management in the winter range; and 3) a Canada - United States - Mexico agreement to manage its habitat and prey.

To facilitate this, the Recovery Team has proposed that a representative from Texas and Mexico be asked to participate in future meetings.

Preventing human disturbance at nests is important since Ferruginous Hawks are among the most sensitive of raptors to disturbance. One visit to the nest before or during egg-laying will usually result in the pair abandoning the site; some pairs will even abandon nests when they have small young or if a curious observer lingers near the nest tree. Although public attitudes towards raptors are more enlightened than in the past, shooting losses still occur. Disturbance and shooting can be discouraged by: 1) providing information guidelines to industry, recreational users, and landowners; 2) encouraging enforcement of existing laws; 3) fostering a positive public attitude; and 4) working towards additional protection on the winter range.

Regarding landowner awareness, it never hurts to point out that Ferruginous Hawks are a threatened species and that a single pair and their young can take 500 ground squirrels in a nesting season.

Recovery of the Ferruginous Hawk also calls for continued population monitoring at certain sites, including: 1) periodic reevaluation of species status (prairie-wide inventories should be conducted at 5-year intervals); 2) encouraging ongoing monitoring in selected study sites; 3) facilitating maximum use of the data collected (by collecting compatible data in all jurisdictions); and 4) monitoring population dynamics (i.e., natal site fidelity, productivity, limiting factors, mortality and survival rates, recruitment, etc.).

Populations declined throughout the prairies in 1991. Manitoba's population declined for the first time since monitoring began in 1987 (from 56 to 48 pairs—a 14% drop). This was not as severe as declines in the Hanna, Alberta study area (Joe Schmutz pers. comm.) and in Saskatchewan (Stuart Houston pers. comm.); in both areas, a drop-off in ground squirrel numbers may have contributed to declines and lowered productivity. A prairie-wide census of Ferruginous Hawks is slated for 1992; the current suspicion is that populations are returning to more normal levels after several years where drought and abundant ground squirrels contributed to elevated populations on the prairies. The Recovery Plan recommends that the species' status be reviewed in 1997; the species may be down-listed at that time if populations remain stable. Delisting is recommended if key habitats and nest sites are secure, and if populations remain above target levels (2500 pairs in the prairies including at least 100 pairs in Manitoba, 800 in Saskatchewan, and 1400 in Alberta).

LOGGERHEAD SHRIKE

The current status, limiting factors, and recovery objectives for the Loggerhead Shrike are not as clear. Numbers of this species have been declining and its range shrinking across North America. Such widespread and uniform declines without apparent cause are rare and have prompted concern from jurisdictions throughout its range. In Canada, the species was declared threatened during the mid-1980s and a recent status report recommended an endangered status for the eastern subspecies (which nests from southeastern Manitoba to Québec).

Loggerhead Shrikes prefer grassland sites, often heavily grazed or mowed. They also require shrubs and trees for nesting and for hunting perches (although utility wires and fences are preferred hunting perches, where available). Some populations thrive in areas where few grasslands remain. Manitoba's densest nesting populations occur in shelterbelt-dominated townships near Lyleton in the extreme southwest. Territories in this area are dominated by cropland and the only grasslands that remain are along roadside ditches.

The principal drawback to recovery efforts for the Loggerhead Shrike is that the cause or causes of population declines are unknown. Nesting success and productivity seem adequate. Post-fledging losses may be considerable, but are nearly impossible to assess (radio-telemetry studies are needed). Habitat loss is believed to be one of the main factors that has limited populations of the Loggerhead Shrike. Increased losses to pesticides and automobile collisions have also been blamed. The latter may be more significant than we give it credit for since the numbers of roads on the nesting, migration, and wintering areas have increased substantially and at the same time more shrikes are hunting along roads due to a decline in alternate grassland habitats.

Habitat loss comes in a variety of forms, including: 1) cultivation of grasslands; 2) removal of shelterbelts, hedges, and isolated trees and shrubs; 3) shrub and tree invasion of grassland sites; and 4) loss of nesting and wintering territories to urbanization and industry. Nevertheless, in many parts of its nesting range, suitable habitat remains unoccupied. Many have postulated that habitat on the winter range may be limiting and that prairie populations could be facing serious competition for remaining habitat with local resident populations. Undoubtedly, habitat losses have and are still occurring on the winter range. However, my impressions from having spent three weeks last spring examining shrike habitat use in Texas and Louisiana is that here too there is plenty of available habitat that is unused or underutilized.

The most recent draft of the national recovery plan for Loggerhead Shrikes (Telfer 1990) calls for establishment of stable or increasing breeding populations of over 1000 adults in each of Alberta, Saskatchewan, and Manitoba, and a stable population of the eastern subspecies of over 1000 birds in Ontario and Québec combined. This will require action in three fronts: 1) background studies and research; 2) management actions; and 3) socio-political actions.

Background studies and research are required in order to understand why populations are declining; until this is known, recovery measures will remain tentative. These would include: 1) monitoring status and distribution (to document population changes and response to management initiatives); 2) assessing

population dynamics (productivity, recruitment, mortality and survival rates, etc.); 3) delineating the winter range (currently, there are only five recoveries of prairie Canadian shrikes on winter range); 4) qualitative descriptions of habitat (does suitable but unoccupied habitat suggest a lack of shrikes to fill available habitat or our inability to assess habitat needs?); and 5) quantitative assessments of breeding and wintering habitat. The status and distribution of Loggerhead Shrikes has been monitored in southwestern Manitoba since 1987. Normally, about 250 pairs are found each year, a total that has remained constant despite ever-increasing survey time and effort, and better knowledge on where and how to find them. In the northern half of the intensive study area, populations have declined by at least 38% since 1989. Shrike survey routes set up in southwestern Manitoba during 1987 and 1989 will be resurveyed as part of a prairie-wide effort to reassess the species' status in 1992. Additional surveys are also planned to assess the status of the endangered subspecies in southeastern Manitoba.

Since 1987, nearly 600 shrike nests have been monitored and over 2000 young and adult shrikes have been banded. Our understanding of population dynamics and limiting factors in Manitoba have increased immensely, but the real benefits of this long-term study are just emerging. In 1991, for instance, 4% of nesting adults in southwestern Manitoba were previously banded. While this may not sound like a high percentage of returns, it is far higher than those recorded in other prairie study sites, and we expect these percentages and our knowledge on management concerns to increase substantially in coming years. These results have generated interest in other circles; University of Manitoba students who assisted in the Grasslands Birds Study in 1991 will be initiating studies on Loggerhead Shrikes and Baird's Sparrows (*Ammodramus bairdii*) during 1992. Local conservation organizations from Pierson and Reston have expressed an interest in our research and have applied for Endangered Species Lotteries funding to assist in management initiatives for Loggerhead Shrikes and Burrowing Owls.

Management actions proposed in the draft Loggerhead Shrike Recovery Plan, include: 1) protection of key nesting habitats (might even include protection of known nesting areas in some areas since certain nest sites are used on an annual basis); 2) creation of nesting areas (including shelterbelt establishment, or planting trees and shrubs in large expanses of open grassland); and 3) development of contingency plans should shrikes continue to decline (including exploring captive-breeding and reintroduction).

Socio-political actions outlined in the recovery plan include: 1) working to increase support for shrike conservation among nongovernment organizations and government agencies in Canada, United States, and Mexico; and 2) developing public support and awareness.

Public support and awareness for threatened and endangered grassland birds in Manitoba has been enhanced by: 1) public presentations to naturalists, school groups, and other interested organizations; 2) displays and exhibits at National Wildlife Week, the Brandon Winter Fair, etc.; 3) newspaper articles, radio, and television reports; 4) tours of the study area (through Operation Lifeline, and to local interest groups); 5) preparation and distribution of brochures (a prairie-wide brochure is nearing completion for the Ferruginous Hawk and one is planned for the Loggerhead Shrike); 6) involving local enthusiasts and conservation organizations in day-to-day activities and management initiatives; and 7) our continued presence in the southwest (including regular contact with landowners where these species occur).

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PEREGRINE FALCON RECOVERY PROJECT: MANITOBA PERSPECTIVE

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INTRODUCTION

Once plentiful and nesting across Canada, the *anatum* subspecies of the Peregrine Falcon (*Falco peregrinus*) was nearly extinct by the 1960s. In 1970, a joint Canadian-American study predicted that the subspecies would disappear from North America by the end of the decade (Cade and Fyfe 1970). The decline was related to lowered reproductive success due to chemical pesticides, especially DDT (Erickson et al. 1988). International concern over the decline of the subspecies led to the development of a Canadian recovery effort.

Between 1976 and 1987, 563 young peregrines have been raised at the Canadian Wildlife Service (CWS) breeding facility at Wainwright, Alberta, and released across Canada in an attempt to enhance recovery of the species (Holroyd and Banasch 1990). Eighty percent of the fledglings have survived to independence three weeks after the release and their survival is only a start (Davies 1987). The ultimate goal for the prairie provinces, as described in the National Recovery Plan, is to establish a total of 10 territorial pairs within this area by 1992.

Historically, the Peregrine Falcon's occurrence in Manitoba was regarded as a regular migrant and a rare breeder. Manitoba's recovery program began in 1981 with the first release of captive-bred falcons in Winnipeg. In 1990 and 1991, the Manitoba Peregrine Falcon Recovery Project expanded outside Winnipeg to include Brandon, Portage la Prairie, and Gimli. From 1981 to 1991, the Endangered Species and Nongame Section of the Wildlife Branch, Manitoba Department of Natural Resources (DNR), supervised the release of Peregrine Falcons in Manitoba. This report discusses the recovery efforts in Manitoba up to December 1991.

RELEASES

During the last 10 years, 79 Peregrine Falcons have been released in Manitoba (Table 1), the majority

Table 1. Summary of Peregrine Falcons in Manitoba 1981 to 1991.

Total number of birds (hacked and wild)	92[a]
Total number birds hacked	79
Largest hack in a single year (1991)	30
Sex ratio of young birds	42M, 45F
Returned and identified in Manitoba > 1 year after release	4M
Originating outside of Manitoba	1M, 4F
Identified outside Manitoba (Edmonton, Regina, Vera Cruz, and Fargo)	4
Killed (accidents)	15
Injured (2 died, 2 euthanized)	5
Unreleasable; education birds (Quebec, British Columbia, and Manitoba)	4
Number shot	3
Killed by predator (suspected)	1
Rebabilitated and released	0
Unknown (up to 1990)	37

[a] Total does not include migrants, or unidentified banded peregrines.

(about 80%) originating from the CWS peregrine breeding facility at Wainwright, Alberta. Some peregrines came from the Saskatchewan Cooperative Falcon Project, University of Saskatchewan, Saskatoon (15%), and the Raptor Research Centre, McGill University, Quebec (5%).

Between three and eight (average four) Peregrine Falcons were released each year (over the entire 10 year period) from residential and urban buildings in Winnipeg including Fort Osborne Barracks, Mary Speechly Hall (University of Manitoba), Confederation Building, Grain Exchange Building, United Grain Grower's Building, and 200 Tuxedo. Brandon became involved with the peregrine release project in 1990, releasing birds from the roof of the McKenzie Seeds building during the next two years. In 1991, Portage la Prairie and Gimli became involved, releasing peregrines from the roof of Regency House and an old three-story school house respectively. The largest release (30) occurred in 1991 when Winnipeg released six and fostered two, Brandon 12, Portage la Prairie six, and Gimli four birds.

From 1983 on, from one to four peregrines were observed in Winnipeg during the breeding season, although no nesting took place. To encourage nesting, several nest-boxes were placed on downtown rooftops —two on the Delta Winnipeg Hotel, one on the Royal Bank Building, and one on a condominium at 200 Tuxedo. Additional nest-boxes were constructed on the roofs of three apartment blocks, one at the University of Manitoba, and two more at Stony Mountain Penitentiary. Although peregrines from the 1990 release were not observed in Brandon, nest-boxes were installed in 1991 on several buildings.

Mortality encountered during the program included accidents and shootings. Over the course of 10 years, 15 peregrines are known to have been killed accidentally, the majority were young of the year which were relatively inexperienced fliers. Three birds were shot. The whereabouts of at least 37 birds are unknown: some birds may have survived to reproduce.

NESTING

In 1988, a pair of peregrines (5P9, male released in Winnipeg, and P27, female from Minneapolis, Minnesota) were observed in downtown Winnipeg during the summer and fall. In 1989, these birds returned to downtown Winnipeg, and for the next two years, they nested and raised eight chicks on the Delta Winnipeg Hotel (Table 2).

Behaviours associated with courtship such as cooperative hunting and feeding of the female by the male were observed each spring from 1989 to 1991. During early courtship, copulation was also observed frequently. Nest scrapes were observed in the east and west nest-boxes and on a natural ledge on the northeast corner of the Delta Winnipeg Hotel, and early in the pre-nesting season, the female would frequent all three locations.

Table 2. Summary of nesting on Delta Winnipeg Hotel, 1989 to 1991.

	1989	1990	1991
First sighting of pair	Mar. 31	Mar. 28	Apr. 3
Number of eggs laid	4	3	4
Nesting location[a]	W NB	E ledge	W NB
Est. date of last egg laid	May 11	May 4	May 4
Est. date hatch	June 9-11	June 1-4	June 1-3
Number chicks hatched	4	2	2
Sex	4M	1M, 1F	2F
Banding date	June 27	June 29	July 4
Date first flight	July 14	July 13	July 13
Age at first flight (days)	34-36	40-43	40-42
# survived until departure	3	2	2

[a] W = West, E = East, NB = Nest-box

A video camera provided by Advance Electronics was placed on or near the nest ledge each year to allow for a picture of the nest-box interior and one-half the nest ledge. A video monitor was placed in the Delta Winnipeg Hotel lobby for viewing the growth and behaviour of the falcons and a video cassette recorder was used to record activities. The general public was encouraged, through radio, newspaper, and television press releases to view the falcons in the nest-box via the television monitor and to view a DNR display on peregrines. Volunteers and staff were stationed in the hotel lobby to answer questions and solicit donations for the Peregrine Falcon Recovery Project. These peregrines and their offspring were commonly observed to roost, perch, hunt, and feed on or near the following buildings: Delta Winnipeg Hotel, First City Trust, Royal Bank, J.R. Richardson Building, Trizec, Newport Centre and Toronto Dominion Centre among others.

In 1989 and 1991, four eggs were laid in the west nest-box. In 1990, three eggs were laid on the triangular ledge overlooking Portage Avenue and Smith Street (Table 2). During late April, both the female and male shared incubation responsibilities.

The nestling period averaged approximately 40 days. Initially, the male provided most of the food, but during the later part of the nestling period, the female also hunted. In 1989, the female was observed chasing the male and calling on many occasions. These behavioral observations suggested that this inexperienced male was not bringing enough food, and supplemental feeding of two or three quail (*Coturnix coturnix*) per day was initiated for one month.

Young falcons were capable of walking along the ledge within two weeks of hatching. After six weeks, the young falcons fledged. During the early flight period, some problems occurred. In August 1989, the desiccated carcass of one young peregrine was found inside a compartment opening into the base of the Eaton's powerhouse chimney. In 1990, one chick was found on the street. It was brought to the Assiniboine Park Zoo Hospital for treatment, then returned to the Delta Winnipeg Hotel. Ten days later the same chick had to be retrieved again from the street.

Fledglings usually stayed until late September-early October while the adults were present into November. Peregrines have been observed into December and during the last two years, a peregrine (V52, female from Cedar Rapids, Iowa) has spent the entire winter in the downtown area.

In 1990, an aerial survey over a 3,438 km route was conducted over the northern third of Manitoba for other nesting peregrines. Although no peregrines were observed, 33 potential nesting cliffs were recorded (Duncan 1990).

STUDY OF FOOD HABITS

From 1989 to 1991, food habits were determined from prey remains retrieved approximately every 10 days from rooftops and street level around the Delta Winnipeg Hotel from early May to early October. The rooftops of Eaton's Place, Eaton's, Delta Winnipeg Hotel, Newport Centre, Canada Post Office, and First City buildings were checked on a regular basis for feathers and carcasses for identification. Prey species killed by the adults during observations were also identified.

In 1991, a study was initiated to determine the abundance and availability of prey and non-prey species. Bird surveys were conducted in a method similar to the variable circular-plot technique (Reynolds et al. 1980) and the strip transect method (Emlen 1971). A total of 18 point counts and three line transects were established at 10 locations within and near Winnipeg. Four to 18 counts were conducted between May 8 and September 21, 1991 at each location. Data there were collected and included time, weather, species, sex, number, estimated distance from observer, and habitat type. Census plots were surveyed in the early morning hours between sunrise and up to two hours after sunrise. Plots were established in representative samples of several different urban habitats including riverine, downtown, suburban, industrial, forest, grassland, park, and marsh. Eight different observers collected the data from different locations through the year.

From 1989 to 1991, 356 individuals of 68 species and two individuals of two mammalian species were identified from prey remains collected primarily in downtown Winnipeg. Ninety-six percent of the remains (341) were identified to species and 4% were identified to family.

The prey species most frequently taken by Peregrine Falcons between 1989 and 1991 were Rock Dove (*Columba livia*) (22.6%), Sora (*Porzana carolina*) (12.6%), Northern Flicker (*Colaptes auratus*) (11.1%), Black-billed Cuckoo (*Coccyzus erythropthalmus*)

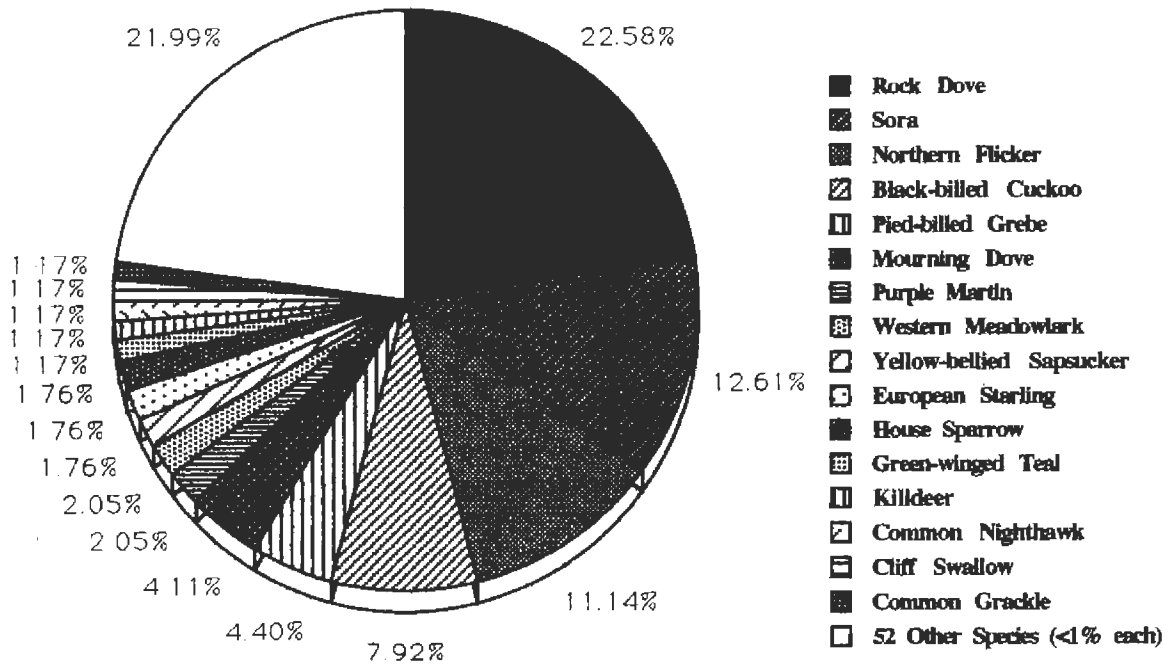

Figure 1. Percent frequency of prey used for species that composed 1% of the diet of Peregrine Falcons in Winnipeg, 1989 to 1991.

(7.9%), Pied-billed Grebe (*Podilymbus podiceps*) (4.4%), and Mourning Dove (*Zenaida macroura*) (4.1%). Of the prey identified in the diet of Peregrine Falcons in Winnipeg, the top six of 68 species accounted for 62.7% of the peregrines' diet. Rock Dove and Sora remained proportionally larger in the diet throughout each of the three sample years than all other species. Sixteen species composed 1% of the diet of Peregrine Falcons, and 52 other species represented 1% of the prey remains, which accounted for 22% of the total diet (Figure 1).

In 1991, 108 species were identified and 9457 sightings were made during bird surveys within and surrounding Winnipeg (including Oak Hammock Marsh, approximately 10 km north of Winnipeg). Eight species composed 53% of available birds. Rock Dove was the most abundant bird recorded (23.4%), followed by Franklin's Gull (*Larus pipixcan*) (16.4%), Ring-billed Gull (*L. delawarensis*) (7.8%), Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*) (5.8%), Mallard (*Anas platyrhynchos*) (5.1%), Red-winged Blackbird (*Agelaius phoeniceus*) (3.9%), House Sparrow (*Passer domesticus*) (3.4%), and Snow Goose (*Chen caerulescens*) (3.2%).

The average number of birds observed over the season in different habitat types was highest in the industrial areas and marshes (Figure 2). Although the variety of species observed was relatively high in the marsh (12 species), it was considerably lower (three species) in the industrial areas (Figure 3). The number of species was highest in rural parks (17 species) and creeks (14 species).

Sixteen of 39 species preyed upon by Peregrine Falcons including Sora, Northern Flicker, Black-billed Cuckoo, and Pied-billed Grebe were taken more frequently than they occurred within the city of Winnipeg. Five additional species were taken in proportions approximately equal to their availability: Rock Dove, American Woodcock (*Scolopax minor*), Common Snipe (*Gallinago gallinago*), and Western Kingbird (*Tyrannus verticalis*); and 18 species were taken in proportions less than their relative abundance: Franklin's Gull, Red-winged Blackbird, House Sparrow, and Mallard. Some of those species taken in proportions less than their availability were not detected in prey remains (unpublished data).

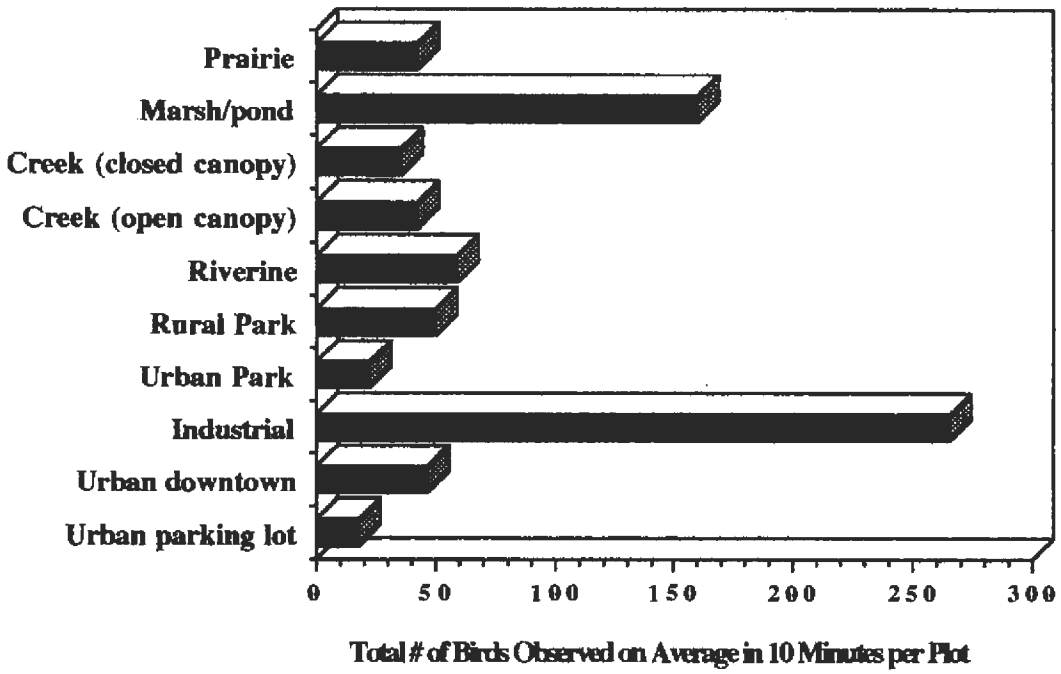

Figure 2. Average total number of birds observed per habitat type within or near Winnipeg, spring-fall 1991.

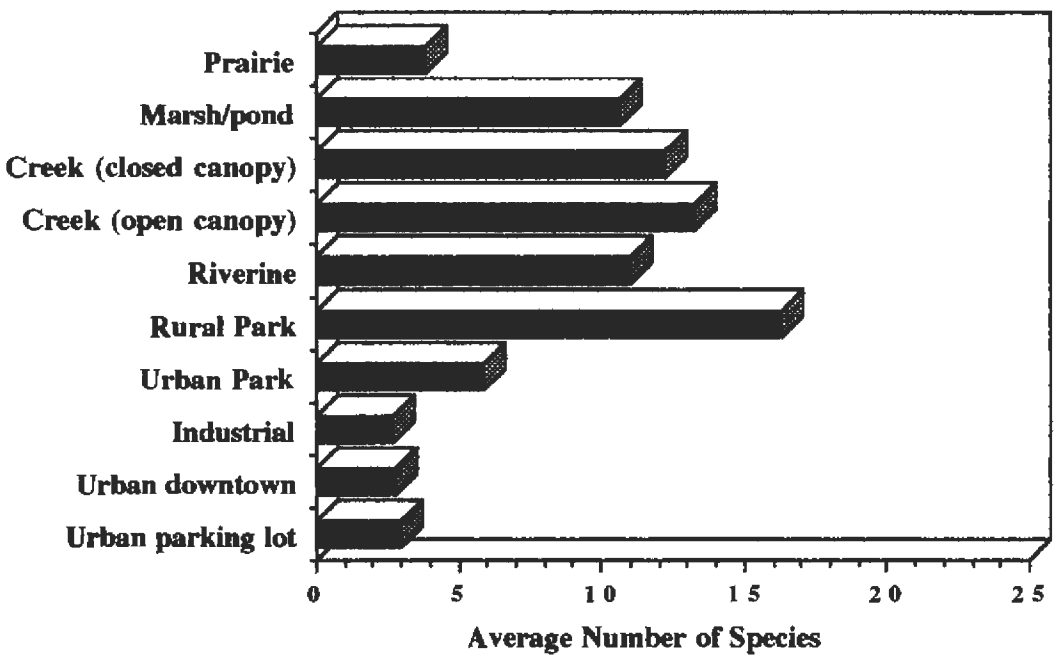

Figure 3. Average number of bird species per habitat type within or near Winnipeg, spring-fall 1991.

Table 3. Summary of pesticide analysis on unhatched egg retrieved from the Delta Winnipeg Hotel, 1991.

Pesticide	Delta Winnipeg Sample ppm (wet weight)	Alberta Average 1991	Canadian Average [1980-1987 (*anatum*)]
HCB	-	0.11	0.279
PCB	2.37	2.98	3.97
Heptachlor Epoxide	0.20	0.38	0.236
Dieldrin	0.04	0.14	0.287
DDT	-	2.84	9.23
DDE	3.62	5.94	9.13

PESTICIDES

In 1990, two of three eggs hatched and in 1991, only two of four eggs hatched from the peregrines nesting on the Delta Winnipeg Hotel. One unhatched egg retrieved in 1991 was sent to the Status and Surveys Section of the Fish and Wildlife Division, Edmonton for analysis (Table 3). It was determined that embryo failure resulted halfway through the incubation and development period. Thin crack-lines encompassed the entire surface of the egg.

The level of DDE found in the Manitoba egg sample appears to be fairly low as critical levels which cause thinning of the eggshell and subsequent failure are around 15-20 ppm DDE (Peakall et al. 1975). Embryo failure resulting halfway through the incubation and development period, and the presence of thin crack-lines which encompassed the surface of the egg, may have been caused by excessively rough handling of the egg by the peregrines.

On September 9, 1991, P27—the resident female which nested on the Delta Winnipeg Hotel during the last three years—was found at the corner of Bishop Grandin and Waverly, Winnipeg, where she had fallen after a collision, presumably with a hydro wire. Both legs were paralysed. She was rushed to the Provincial Vet lab, then to the Assiniboine Park Zoo Hospital for treatment. Unfortunately, she lived only a couple of days.

One set of tissue samples from this bird was sent for analysis. The remarkably high DDE level in her fat content called for a second set to be analyzed for verification. Additional brain, fat, and breast muscle samples from the Delta female, and comparable samples from a young peregrine found dead in Portage la Prairie, were also sent as a control sample (Table 4).

Table 4. Organochlorine residues in the tissues of an adult and a hatch-year female Peregrine Falcon which died in Manitoba, 1991.

	Organochlorides (ppm wet weight)				
Tissue Sample	HCB	beta BHC	H.E.	PCB	DDE
Adult Female (P27)					
Fat (Sample 1)	.001	.320	3.73	20.7	196.5
Fat (Sample 2)	-	.422	6.38	39.4	125.0
Brain (Sample 1)	.005	.007	.088	0.73	3.460
Brain (Sample 2)	-	-	.344	-	12.85
Muscle	-	.024	.772	3.14	74.50
Hatch-year Female (GY)					
Fat (Sample 1)	.100	-	.017	-	.046
Fat (Sample 2)	-	-	.049	-	.097
Brain	-	-	-	-	.027
Muscle	-	-	-	-	.010
Liver	-	-	0.12	-	.010

There were no significant findings for the final diagnosis of P27. The necropsy did not show any abnormal conditions, and her weight (950 g) was not any lower on average (899 ± 75 g) than other *anatum* adult female peregrines (Court et al. 1988). As expected, body fat reserves were considerably lower than the hatch-year female's fat reserves.

Results showed that DDE in the fat averaged 160.7 ppm, and the brain tissue averaged 8.15 ppm wet weight for the Delta female. The highest DDE level of 12.85 ppm found in the brain stem of this female was approximately the same as the highest average brain tissue level found in Canadian raptors during 1967 to 1985 (Noble and Elliot 1990). The DDE in muscle tissue was also high (74.5 ppm) as compared with an adult male peregrine (47.1 ppm) found dead in the NWT (Court et al. 1990).

DISCUSSION

The initial success of the program was realized in 1983 when peregrines began returning to their place of origin. One to four Peregrine Falcons were observed in Winnipeg each year during the breeding season. Other Peregrine Falcons originating from the United States were also attracted to Winnipeg. Although peregrines from the 1990 release were not observed in Brandon, nest-boxes were installed in 1991 on several buildings in preparation for their arrival and to encourage nesting. The mass hack of 30 Peregrine Falcons in 1991 from four urban centres holds much promise for a number of these birds to return to Manitoba in spring, 1992.

In 1989, another milestone in the program was reached when a pair of Peregrine Falcons nested on the Delta Winnipeg Hotel. Over the next three years they successfully raised eight young, and seven of these birds survived until their departure. In 1990 and 1991, one offspring male (born in 1989) from the Delta pair returned to Winnipeg. He paired with two different females at the University of Manitoba during these years but they failed to produce a clutch. Age and inexperience were likely the reasons why they did not produce young. There is a good chance, however, that if these birds return in 1992, they will reproduce.

A successful aspect of the peregrine release program in Manitoba was the favourable media attention and the opportunity for public education to the plight of an endangered species. Each year, between 30 and 60 news articles were released via newspaper, television, and radio. Shopping mall displays during Wildlife Week, the display and television monitor at the Delta Winnipeg Hotel, public interpretation at shopping malls, interpretation while viewing peregrines from parking lots and parks surrounding hack sites, and university lectures all provided unique opportunities for education.

Mortality encountered during the program included accidents and shootings. Over the course of 10 years, 15 peregrines were killed accidentally; the majority were young of the year and relatively inexperienced fliers. Three birds were shot. The whereabouts of at least 37 birds are unknown; some of these birds may have survived to reproduce.

Some concern was expressed by the public over the potential over-exploitation of local songbirds such as robins and warblers by Peregrine Falcons. The prey preference study conducted from 1989 to 1991 suggests that a wide range of species are used by Peregrine Falcons in Winnipeg, but only a few species account for a majority of the diet. The main prey species, Rock Dove, appears to be selected on the basis of frequency. Sora, Northern Flicker, and Black-billed Cuckoo are relatively uncommon in Winnipeg as shown by the prey availability study, but they are selected for prey during the early to mid-season, suggesting that there is a local irruption of these two species, or there is some energetic benefit to peregrines when they hunt these birds. Rock Dove, Sora, Northern Flicker, Black-billed Cuckoo, and Pied-billed Grebe constituted a relatively large portion of the diet (60%) and should be considered important prey. Local songbirds were hunted by peregrines, but a very low percentage of these individuals was present in the diet.

Prey that fly through open areas in Winnipeg over parking lots, buildings, industrial areas, or above the parkland canopy may be more susceptible to predation by peregrines. Prey behaviour may provide additional opportunities for capture by peregrines, or they may concentrate on prey with obvious flash patterns in the feathers (e.g., Northern Flickers' bright yellow undertail coverts and primaries). Hunter et al. (1988) suggest that selection of particular prey species likely was influenced by a combination of factors in their study area including prey habitat, susceptibility, abundance, behaviour, physical characteristics, and predator characteristics such as hunting ability.

High levels of organochlorines, especially DDE levels in the Delta female, raised the possibility of

indirect mortality through poisoning. If P27 was stressed and she had low fat reserves, there is a possibility that the organochlorines in her system contributed to her accidental death. Peakall et al. (1990) suggest that the best estimate of critical levels of DDE in the brain which directly causes mortality are above 200 mg/kg, but there are no studies available which suggest how and to what degree organochlorine levels can affect flight performance. Court et al. (1990) stated that organochlorines such as Dieldrin, DDE, Heptachlor Epoxide, and PCBs have been implicated as the cause of death in a number of raptor species. They proposed that birds retain these lipid-soluble compounds in body reserves and are subsequently poisoned when reserves are suddenly utilized in times of stress, specifically during breeding, the moult, or migration. Adult females have shown evidence of stress during the breeding season and show a considerable drop in body weight between arrival and the nestling-rearing stage, up to a 20% reduction in some cases. Birds leaving the breeding grounds carrying the highest levels of organochlorines might be the least likely to survive the wintering season (Court et al. 1990).

The hatch-year peregrine hacked in Portage la Prairie did not show significant levels of organochlorines as expected. The levels obtained in this young bird, however, demonstrate that they retain some residues originally present in the egg yolk (Court et al. 1990). Organochlorines could also have been picked up from either the quail it was fed, or if it managed to kill and eat some prey during the 15 days it was flying after release from the hack-box.

ACKNOWLEDGMENTS

We would like to thank the following organizations and people for their contributions in the development and support of the Manitoba Peregrine Falcon Recovery Program: Members and volunteers of the Manitoba DNR who supervised the program, committed themselves to public education and fund-raising, and those people too numerous to mention, who built and placed hack-boxes, nest-boxes, conducted surveys, and rescued peregrines over the course of ten years. Special thanks to Robert W. Nero for his relentless dedication and perseverance to Manitoba's peregrine recovery effort. We would also like to thank the following organizations: The Peregrine Falcon Recovery Project Manitoba, CWS, the Zoological Society of Manitoba, Manitoba Wildlife Rehabilitation Organization, Assiniboine Park Zoo, the Delta Winnipeg Hotel, the United Grain Growers, McKenzie Seeds, Eaton's, Advance Electronics, SWAT Exterminators, Manitoba Lotteries Foundation, Winnipeg Real Estate News, Gimli Environmental Council, Portage Natural History Society, Sunridge Management, University of Manitoba, and the Alberta Fish and Wildlife Division.

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ORGANOCHLORINE CONTAMINANTS IN MIGRANT AND RESIDENT PREY OF PEREGRINE FALCONS IN PANAMA, VENEZUELA, AND MEXICO

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ABSTRACT

During 1984 to 1989, we collected Peregrine Falcon (*Falco peregrinus*) prey species, in the fall and the following spring, in Panama, Venezuela, and Mexico to determine the levels of organochlorine contamination. The mean DDE levels, by country, for all samples ranged from 0.28 to 0.68 ppm; for spring samples the DDE levels ranged from 0.02 to 1.12 ppm. The spring migrants collected in Mexico exceeded 1.00 ppm DDE, the more conservative DDE level considered sufficient in prey to effect decreased productivity in peregrines. Some species collected in the fall arrived with more than 1.00 ppm DDE in their tissues. Detected DDT levels were also low, indicating the presence of an alternate source for the higher DDE levels, possibly in North America (Banasch et al., in press).

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FOOD HABITS OF NESTING PRAIRIE FALCONS IN SOUTHERN ALBERTA, CANADA

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SUMMARY

Diet and feeding behaviour of eight pairs of nesting Prairie Falcons (*Falco mexicanus*) in southern Alberta were examined in 1989 and 1990. Prey were identified by direct observation of prey delivered to the nest site, and by examination of prey remains from perch sites and pellets. Comparison of species composition derived using the two techniques demonstrated that collections of pellet and prey remains misrepresented the percent frequency and percent biomass of Richardson's Ground Squirrel (*Spermophilus richardsonii*) and birds in the diet. Using direct observation we determined that Richardson's Ground Squirrels accounted for 68% of all delivered prey items (n = 250 items). Analysis of prey remains and pellets was used to identify the species of birds and small mammals in the diet. Birds, primarily Western Meadowlark (*Sturnella neglecta*), European Starling (*Sturnus vulgaris*), and Horned Lark (*Eremophila alpestris*), comprised 27% of the diet. The remaining 5% of the diet consisted of small mammals. Male falcons delivered 71%, 71%, and 57% of prey during incubation, nestling, and fledgling stages, respectively. Primary prey of male falcons switched from Richardson's Ground Squirrels to birds in June. This change corresponded in time with the doubling of prey delivery rates of female falcons. Female falcons delivered primarily ground squirrels throughout the nesting cycle. A conservation implication of this data is that Richardson's Ground Squirrels and their habitat must be maintained if Prairie Falcons are to continue breeding in southern Alberta.

WHOOPING CRANE CONSERVATION

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INTRODUCTION

After listening to various presentations in this workshop and in the two previous workshops it appeared evident to me that no single individual or institution can prevent species from becoming endangered. It bas taken and will take a cooperative role by many participants. Nowhere is there a better example of cooperation in wildlife management than in the story of the Whooping Crane (*Grus americana*). The Whooping Crane is known as the symbol of efforts to preserve rare and endangered species in North America (United States Fish and Wildlife Service [USFWS] 1986, Cooch et al. 1988).

In Canada the Whooping Crane program has benefitted from the cooperation of organizations such as the Canadian Wildlife Service, the Saskatchewan Museum of Natural History, the Canadian Parks Service, the Governments of Manitoba, Alberta, and, in particular, Saskatchewan, the Whooping Crane Conservation Association, the Saskatchewan Natural History Society, and the Saskatchewan Wildlife Federation. In the United States there are an equivalent number of organizations, all with the same common goal "To prevent the extinction of the Whooping Crane and other endangered species."

POPULATION AND RANGE

The Whooping Crane was never a very numerous species, the best estimate of thc population is about 1350 individuals around 1865 (Allen 1952). At that time, Whooping Cranes occupied their primary breeding range which extended from central Illinois to the northwest through Iowa, Minnesota, North Dakota, Manitoba, Saskatchewan, and into Alberta. The Great Plains of Canada and the United States still contained an abundance of lakes, marshes, and other wetlands where Whooping Cranes could safely nest and feed. During the late 1800s and early 1900s the Whooping Crane breeding area underwent a drastic change. Settlement of the prairies began and prairie wetlands and uplands were converted to agricultural lands. During this settlement period, Whooping Cranes, besides losing the major portion of their breeding habitat, were hunted for food and feathers. Museums and collectors were also after specimens and eggs. In Manitoba all known nests between 1871 and 1906 had their eggs taken by collectors. The last nesting record for the United States came from Iowa in 1894. Manitoba's last known nesting was in 1906, followed by Alberta in 1914 and the last nest in the prairies of southern Canada occurred in Saskatchewan in 1922 or perhaps as late as 1927 (Allen 1952, Johns, in press). As a result the migratory population plummeted to a low of only 16 birds by 1941 (Allen 1952). A small nonmigratory population persisted in Louisiana until 1948 when it finally died out.

Today, the Whooping Crane population numbers around 212 birds. One hundred and forty-four birds are in the wild and another 68 birds are in captive breeding facilities. The current breeding range consists of a few small areas within Wood Buffalo National Park (WBNP) (Kuyt and Goossen 1987).

The historical wintering areas of Whooping Cranes were the coasts of western Louisiana and Texas, and the high plateaus of central Mexico (Allen 1952). Today, Whooping Cranes winter on the Texas coast, on and near the Aransas National Wildlife Refuge (ANWR) and an experimental population winters in central New Mexico.

The migration corridor of the Aransas/Wood Buffalo population of Whooping Cranes extends north from the ANWR through the states of Texas, Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota, and into southeastern Saskatchewan. From here the birds cross the province in a diagonal towards the northwest, across northeastern Alberta and into WBNP (Kuyt 1992).

LIFE CYCLE

Whooping Cranes begin the year on their wintering grounds, feeding on the rich invertebrate life in the coastal marshes of southern Texas. The birds are in small groups, each defending a small winter territory from intruders. Groups consist of single birds, pairs, family groups (usually 2 adults and 1 young), and larger non-breeder groups.

During early April, these small winter flocks begin the northward migration either alone or in combination with other winter groups. The cranes begin arriving in northern WBNP 19 to 28 days after leaving Texas (Kuyt 1982). Shortly after their arrival, the breeding birds begin nest construction.

Nests are generally constructed of bulrush (*Scirpus* sp.), sedge (*Carex* sp.), or Common Cattail (*Typha latifolia*), in about 25 cm of water. Usually two eggs are laid (92% of the time), sometimes only one egg (7%), and rarely 3 (1%) (Cooch et al. 1988). Incubation takes 29-30 days (Kuyt 1982). After hatching, young Whooping Cranes feed in the shallow marshes (invertebrates and small vertebrates) and also in uplands (berries) with their parents for the remainder of the summer.

Usually after the middle of September, Whooping Cranes begin their southward migration. The autumn migration is the reverse of that of the spring, with the exception that the cranes may spend several days or weeks in the south-central portion of Saskatchewan feeding on waste grain before continuing with migration to Texas.

MANAGEMENT

Protection Of Whooping Cranes

Whooping Cranes have been protected in North America since the signing of the Migratory Birds Treaty with the United States in 1916. Their breeding area has been protected as a national park since 1922, and the wintering grounds have been protected as a national wildlife refuge since 1937. The Canada Wildlife Act of 1974 provides additional authority to undertake work on any endangered wildlife in Canada.

A memorandum of understanding exists between Canada and the United States to share equally in the decision making concerning the direction that the cooperative Whooping Crane program should take. A Canadian Whooping Crane Recovery Plan (Cooch et al. 1988) has been in effect since 1987. Its purpose is to provide guidelines to direct the recovery of the species to the point that it can be downlisted to threatened from its current endangered status.

Management On The Wintering Area

During the winter, censuses are conducted on a weekly basis, by the USFWS, to determine and document: the current winter population; movements of colour banded individuals; new pair formations; and any mortality that may occur. Upland foraging habitat is being managed by periodic burning to control shrubby growth and to stimulate the production of acorns, which are a favourite upland food of the wintering cranes. There have been attempts to prevent destruction by erosion of the cranes aquatic foraging habitat, by sandbagging portions of the Gulf Intra Coastal Waterway (T. Stehn, pers. comm.). During 1991 an attempt was made to create new marsh habitat, to offset losses that occur due to erosion, along the waterway.

Management On The Breeding Grounds

During the breeding season surveys are carried out to locate Whooping Cranes and to identify breeding pairs and their egg laying dates for later manipulation and removal of eggs. Late in the incubation period eggs are tested for viability. Each pair checked is left with at least one viable egg in its nest. Nonviable and surplus viable eggs are removed from nests. The surplus eggs have been placed into captive rearing facilities at the Patuxent Wildlife Research Center (PWRC) in Maryland and the International Crane Foundation (ICF) in Wisconsin, or into Sandhill Crane (*Grus canadensis*) nests in Idaho.

During the summers of 1977 through 1988 young Whooping Cranes were colour banded to provide information on location and movements of marked birds, age of sexual maturity, fidelity of birds to their mate and territory, reproductive capacity, identification of important migration habitat, and longevity of the Whooping Crane (Kuyt 1979).

Efforts To Increase The Population

Several approaches have been employed to increase the Whooping Crane population. Whooping Cranes lay two eggs, generally only one young will survive to

fledging. Beginning in 1967, surplus eggs were removed and placed into captive breeding facilities. To date there are 68 birds in captive breeding facilities. There are 38 birds at the PWRC, another 28 birds at the ICF, and two birds at the San Antonio Zoo in Texas. There may be another captive breeding flock established, in the near future, at the Devonian Conservation Research Centre in Alberta, a branch of the Calgary Zoo. The purpose of the captive breeding facilities is to provide offspring that could be released into the wild to create additional discrete populations. To date only one or two birds have been released (Grays Lake, Idaho) and none survived.

Between 1975 and 1987 the majority of the eggs removed from WBNP were transferred to Grays Lake National Wildlife Refuge in Idaho, in an attempt to establish another wild population. Here the eggs were placed into nests of greater Sandhill Cranes after the removal of the Sandhill Crane egg. The Sandhill Cranes raised these foster young as if they were their own. This population peaked at 33 birds in 1984. However, years of successive drought leading to poor production of foster young, abnormally high mortality and no pair formation or breeding attempts by the Whooping Cranes has reduced the population to 12 birds (R. Drewien, pers. comm.). A recent study of the vocalization patterns of these foster reared Whooping Cranes has been completed, indicating that vocalizations are learned from other cranes (Carlson, in press). This indicates a degree of imprinting that may have severe consequences in any release of captive reared birds or further attempted foster rearing of Whooping Cranes, especially if they cannot communicate adequately with each other or with wild Whooping Cranes that they may encounter.

Between 1975 and 1991 eggs in WBNP, have been tested for viability, this testing and the transfer of viable eggs into nests with nonviable eggs has resulted in an increase of 16-20% in hatching success of this population (E. Kuyt, pers. comm.).

Between 1977 and 1980 a study of Sandhill Cranes was carried out in the Interlake area of Manitoba (Melvin et al. 1990). The purpose was to find a suitable population of Sandhill Cranes that could be used for another fostering experiment. The Interlake Sandhill Cranes wintered near the existing Whooping Crane flock and with the failure of the Whooping Cranes to breed in Idaho, any attempts to put Whooping Cranes in Manitoba through foster rearing has been put on hold.

The Future

There is an ongoing study in Michigan looking at integrating captive reared juvenile Sandhill Cranes into flocks of wild Sandhill Cranes (Urbanek and Bookhout, in press). This study was to begin testing the integration of the Red-crowned Crane (*Grus japonensis*), another white crane, in with flocks of Sandhill Cranes, until health problems with the red-crowns forced a halt to the study. If this technique were to prove successful, it may become another method of establishing a migratory flock of Whooping Cranes.

A study on the feasibility of establishing a nonmigratory flock in Florida has been completed. A test release of a few Whooping Cranes was to be attempted during the winter of 1991/92, however, due to a lack of suitable candidate birds, this release has been postponed to at least the fall of 1992.

At present there is a study looking at the feasibility of placing Whooping Cranes into Saskatchewan if a suitable technique can be developed. If successful, this would expand the breeding range, however, it may not meet the criteria for establishing a separate breeding and wintering flock.

The current Wood Buffalo/Aransas population consists of 41 potential breeding pairs and 50 subadults. During 1991 there was a potential for 40 nests, however, due to poor habitat conditions on the breeding grounds (i.e., low water levels) there were only 33 nests. From those 33 nests only eight young survive. When habitat conditions improve, most of those pairs should nest and there could be a record number of young produced.

ACKNOWLEDGMENTS

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AN OVERVIEW OF THE FIRST INTERNATIONAL PIPING PLOVER CENSUS

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One of the difficulties that COSEWIC (Committee on the Status of Endangered Wildlife in Canada) and the United States Fish and Wildlife Service face when evaluating species' status, is the uncertainty of total population estimates. Often, accurate population numbers are not available for candidate species and biologists can only offer best guesses or general estimates based on regional counts. Prior to the 1991 census, the question as to how many Piping Plovers (*Charadrius melodus*) remained could also only be speculatively answered using regional counts and estimates (Haig et al. 1988, Goossen 1990). In this paper, we present highlights from the results of the 1991 census (Haig and Plissner, in press) and give special attention to Piping Plovers breeding in the Canadian prairies.

In 1991, Piping Plovers were counted in one of North America's most comprehensive endangered species censuses, involving over 1000 volunteers and biologists from 10 nations (Haig and Plissner, in press). Within six months, most Piping Plovers on both wintering and breeding grounds had been censused, giving biologists the first comprehensive count of this species. The census was coordinated through the four North American Piping Plover Recovery Teams (two in Canada and two in the United States). The teams were responsible for ensuring the census was done by state, provincial, and nongovernment agencies in their respective regions.

In 1991, the North American breeding population consisted of approximately 5,480 adults. The Northern Great Plains of the United States and the Canadian prairies harboured the majority (63%) of breeding Piping Plovers. Piping Plovers in prairie Canada (Alberta, Saskatchewan, Manitoba, and northwestern Ontario) constituted 41% of the Great Plains/prairie population and 26% of the total Piping Plover population. Most Piping Plovers in prairie Canada were found in Saskatchewan. About 1,170 adults were counted there, representing about 21% of the total Piping Plover population. The previous highest count in Saskatchewan was in 1984 when 802 individuals were counted for a provincial estimate of 2000 to 2500 (Harris et al. 1985). The most populated breeding site in North America in 1991 was Lake Diefenbaker which harboured 5% of all adult Piping Plovers counted during the 1991 breeding census. Alberta had the next highest provincial count in prairie Canada with 180 adults. This count, however, is 108 adults less than were counted in 1986 (Wershler and Wallis 1987). Previous population estimates for Manitoba have ranged from about 120 adults (Haig 1987) to 200 (Koonz 1988). In 1991, however, only 80 adults were found.

All Piping Plovers in the Great Lakes area occurred in Michigan with the exception of one bird in Wisconsin. No plovers were found at Long Point on Lake Erie, where the last confirmed Canadian Great Lakes nesting was documented in 1977 (Lambert 1987). In Atlantic Canada, approximately 510 Piping Plovers were counted. New Brunswick harboured 40% of the Atlantic Canada Piping Plover population followed by Nova Scotia with 22%.

About 3,450 wintering Piping Plovers were counted on the Gulf of Mexico coast, the United States Atlantic coast, and some Caribbean Islands. Most (55%) wintering Piping Plovers were found in Texas.

The 1991 census resulted in more Piping Plovers being found on both wintering and breeding grounds than previously estimated. No doubt the major reason is the increased search effort. Additional international surveys are required to demonstrate any population trends. Concern for the species must remain as the western population may be in decline (Prindiville Gaines and Ryan 1988).

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THE BURROWING OWL RECOVERY PROGRAM

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Three years ago after the last Prairie Conservation and Endangered Species Workshop, Burrowing Owl (*Athene cunicularia*) people stayed to work on a draft recovery plan. That plan was submitted to RENEW (Recovery of Nationally Endangered Wildlife) for approval on May 22, 1990 (Haug et al. 1990).

While awaiting approval for the plan the recovery team is proceeding with its implementation. This article is a quick overview of the major recommendations of the recovery plan and of some of the projects we have underway for the Burrowing Owl.

First of all a look at the goals of the recovery plan. We have established a target of 2700 pairs of owls in Canada and individual provinces have also established targets. These targets, 100 pairs in Manitoba, 1500 pairs in Saskatchewan, 1000 pairs in Alberta, and 50 in British Columbia also show the general distribution of the Burrowing Owl at present. The vast majority of our population is in Saskatchewan and Alberta.

To meet these goals the plan identifies six major action areas. I wish to give you a review of the recovery plan by a quick look at some projects under taken in each of these six action areas.

MAINTAIN AND INCREASE POPULATIONS ON THE BREEDING GROUNDS

Public education is an important way to lower mortality from human caused activities such as shooting. Several initiatives are underway here. Alberta has published a Burrowing Owl brochure which has been distributed widely. A modified version, to cover the prairies, will be produced shortly. In British Columbia posters have helped create awareness.

Media have covered the Burrowing Owl with banding or other stories on several occasions. We also assisted John and Janet Foster to produce a film on Burrowing Owls for TV Ontario and Japanese Television. Although the film had been shown in Japan and Ontario, few people in the Burrowing Owl range have seen it yet. Wildlife is always more attractive when it's far away and exotic. Nonetheless we are optimistic it will eventually be a useful educational tool on the prairies.

Probably the largest and most successful education effort was Operation Burrowing Owl which produced a great deal of interest due to HRH Prince Philip's participation at the initiation, and which has involved direct communication with landowners who have owls. More about Operation Burrowing Owl later.

Dr. Paul James, working around Regina, Ken de Smet in Manitoba, and Dr. Joe Schmutz in Alberta are monitoring the Burrowing Owl population changes and productivity in their areas. These data and data from Operation Burrowing Owl indicate greater population declines in the eastern parts of their range. They also suggest that mortality is quite high during the migration and winter areas.

At Regina the population has declined since the study began, but productivity is higher last year and we are hoping for a stable population this year. At least part of the decline appears to be due to low productivity due to a declining prey base, especially in 1989 after the 1988 drought. Unfortunately, the population is not showing signs of recovering, instead we think it is stabilizing at a new lower level. This suggests increased mortality is a long term problem.

Dr. James proposes to look at specific mortality factors, especially predation by Red Fox (*Vulpes vulpes*), this summer (1992). Also, research to be initiated in the spring of 1992 through the University of Saskatchewan will examine the factors affecting productivity, especially the effect of food supply. The research may show us ways to increase productivity.

PROTECTION AND MANAGEMENT OF NESTING HABITAT

Although there are unoccupied suitable habitats for Burrowing Owls, at present we also find them nesting in apparently marginal sites such as road ditches. Loss of good pasture habitats in key areas like tbe Regina Plains has been extensive and fragmentation of the remaining habitat into small parcels is also impacting on

the owl. Dr. James will speak on this topic in the session on habitat fragmentation.

The majority of Burrowing Owls on the prairies nest on private lands. Hence direct contact with landowners is very important in maintaining habitat. In Manitoba, agreements and leases have been signed with soune landowners. In Saskatchewan and Alberta, Operation Burrowing Owl is the prime habitat protection mechanism. Under this program, landowners volunteer to maintain the Burrowing Owl nesting habitat in return for recognition, in the form of a gate sign, and an annual newsletter. Landowners also report on their owl population each year.

Since Operation Burrowing Owl was initiated in 1987, 498 Saskatchewan and 226 Alberta landowners have enroled to protect Burrowing Owl nesting areas. In 1991 these areas supported 647 and 357 pairs respectively. In addition the program through brochures, signs, newsletters, and other publicity has greatly increased awareness of the Burrowing Owl as a threatened species.

The recovery team has also identified that current agricultural policies and subsidies strongly encourage farmers to break grassland areas. In the past year programs such as Gross Revenue Insurance Plan, crop insurance, and transportation subsidies effectively pay a farmer in Saskatchewan $40 for each acre he cultivates. Because Burrowing Owls tend to nest on arable lands, these subsidies are a strong impediment to retention of Burrowing Owl habitat. This is of course a concern for other species as well. As a recovery team we have therefore identified our concerns in hopes of contributing to the search for a better solution for wildlife and our farmers.

A very interesting initiative led by Dr. Geoff Holroyd of the Canadian Wildlife Service is use of satellite imagery to identify Burrowing Owl habitat. Initial research has shown that areas of grassland used by ground squirrels are identifiable by satellite. Because of the use of Richardson's Ground Squirrel (*Spermophilus richardsonii*) holes by Burrowing Owls, this technique may also identify Burrowing Owl habitat. Research to determine whether this will work and is applicable outside the initial experimental area is now underway.

POPULATION MONITORING

Designing recovery efforts requires knowledge of the status of the population. To achieve this the small populations in Alberta and British Columbia are censused directly.

In Saskatchewan and Alberta we maintain files of locations where owls are reported each year. In addition, landowners in Operation Burrowing Owl are telephoned and report the number of owls on their property.

At Hanna and around Regina population changes on study blocks are monitored each year.

A standardized survey is discussed and last year Dr. Joe Schmutz experimented with call backs as a survey technique. However, the large areas to be covered make a range wide survey very difficult unless we can define smaller potential search areas, perhaps using satellite imagery. However, the current monitoring is clearly showing the direction the population is moving if not the absolute numbers.

POPULATION MANAGEMENT ON MIGRATION AND WINTER AREAS

One of the large problems with Burrowing Owl management is that we do not know where they spend the winter. We really do not have any band recoveries from what we consider the winter period. We suspect our owls are wintering in Mexico.

Several ways of confirming this are being investigated. We have worked with Mexicans to identify areas where there are Burrowing Owls in winter. We are investigating use of DNA matching to see if we can identify our population in the winter. In addition, we hope to initiate banding projects in Mexico, to see if those wintering owls do come to Canada where there might be a better chance of a band recovery.

ELIMINATE NEGATIVE EFFECTS OF PESTICIDES

As grasshoppers and mice are principle foods of the Burrowing Owl we were concerned about the impact of pesticides and rodenticides on the species. Research has been conducted to look at both potential problems.

Research by Dr. Paul James indicates that Burrowing Owls are not affected when ground squirrels are poisoned around them. This of course does not mean there will never be secondary poisoning, but at least in a series of monitored colonies there was not.

Research on grasshopper spray showed a different result. One chemical, Furadan, was shown to affect brood size and nest success when sprayed near nest burrows (Fox et al. 1989). As a result of this work Agriculture Canada has prohibited use of Furadan within 250 metres of a Burrowing Owl burrow.

RELEASE PROGRAMS

British Columbia has re-established a Burrowing Owl population by releasing owls obtained from adjacent states and captive breeding. Manitoba has also been releasing Burrowing Owls to supplement the small population there. Owls for the Manitoba release were obtained from Saskatchewan until 1991, when owlets were captured in North Dakota. A declining population in Saskatchewan made it desirable to obtain owls from elsewhere so as not to stress the donor population.

The British Columbia experience shows that releases can work. There has been less success in Manitoba, in part because the returning owls do not home precisely to the release areas but spread widely. Hence owlets released in Manitoba might be settling in North Dakota or Saskatchewan.

CONCLUSION

We have been working on these six goals for a couple of years now. Unfortunately, the Burrowing Owl population is still on a down trend. A fragmented habitat and relatively high mortality rates, especially off the breeding grounds, are significant concerns. We would really like to know where these owls winter and in general, many questions about the problems facing this owl remain. Fortunately the population is relatively stable in some areas and even showed an increase in the Wood Mountain area last year. I don't expect this species to disappear in the next few years, but neither are its problems fully understood or resolved.

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THE BIOLOGY OF PRAIRIE BATS

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INTRODUCTION

Of all the organisms that inhabit the prairies, bats are not usually the first ones to come to mind and yet they are a significant and important component of the prairie fauna. Of the 19 species of bats recorded in Canada, nine are found in the prairie provinces (Table 1). The most common of these, and the ones the public comes in contact with the most, are the Little Brown Bat (*Myotis lucifugus*) and the Big Brown Bat (*Eptesicus fuscus*). However, if there is a species that could be considered characteristic of the prairies, it would be the Small-footed Bat (*Myotis ciliolabrum*) which inhabits the arid regions of western Canada including the short grass prairies of Alberta and Saskatchewan (van Zyll de Jong 1985). As with many of the prairie bats, there is remarkably little known regarding the biology of Small-footed Bats. Even for species that are well studied elsewhere, such as the Little Brown Bat, information about the biology of prairie populations is scarce. More than anything else, it is this lack of information that hinders conservation efforts for prairie bats.

MIGRATION VERSUS HIBERNATION

Prairie bats fall into two major categories according to how they deal with the cold temperatures and lack of food (insects) during the winter. Three species migrate south for the winter while the other six hibernate (Table 1). The migratory species, Hoary (*Lasiurus cinereus*), Red (*L. borealis*), and Silver-haired Bats (*Lasionycteris noctivagans*), are amongst the most widespread species of North American bats and yet, due to their solitary habits, we know very little about them. They migrate north into the prairies and boreal forest in May and June and return south in August and September (Barclay 1985a). Silver-baired Bats, in particular, are often encountered by the public at these times (Schowalter 1979). In all the migratory species, males and females appear to migrate at different times, although in Hoary Bats the prairie population may consist almost exclusively of females coming north to bear their young since males are rarely caught (Schowalter 1979, Barclay 1985a).

All three migratory species roost in trees, silver-hairs apparently in crevices in bark (Barclay et al. 1988), reds and hoaries in the foliage (Barclay 1985a, van Zyll de Jong 1985). For this reason much of the prairie population of these species may migrate through the area to forested regions to the north. Those individuals that remain in the prairies undoubtedly rely on treed areas for roosts. For this reason maintaining treed areas along rivers and around farm sites is particularly important in prairie bat conservation efforts.

Table 1. Species of bats from the prairies.

Species	Common Name	Hibernation/ Migration	Colonial/ Solitary
Myotis lucifugus	Little Brown Bat	H	C
Myotis volans	Long-legged Bat	H	C
Myotis septentrionalis	Northern Long-eared Bat	H	C
Myotis evotis	Long-eared Bat	H	C
Myotis ciliolabrum	Small-footed Bat	H	C
Eptesicus fuscus	Big Brown Bat	H	C
Lasionycteris noctivagans	Silver-haired Bat	M/H	C?
Lasiurus borealis	Red Bat	M	S
Lasiurus cinereus	Hoary Bat	M	S

The six species that hibernate may also make seasonal movements out of the prairies, in their case to find suitable hibernacula. Hibernating bats require sites that provide stable, cold (approximately 2 to 6° C), humid conditions and these are usually only found in relatively deep caves and mines. Although there are a few small hibernacula known in central Manitoba (B. Koonz, pers. comm.), sites within the prairies are rare (Schowalter 1979). The majority of bats most likely move north, east, or west to find suitable places to hibernate and this obviously broadens the geographical scope when dealing with prairie bat conservation. In Alberta, for example, male Little Brown Bats are common in the mountains during the summer (Barclay 1991), while colonies of females are most common further east, in the prairies (Schowalter et al. 1979). Females move into the mountains in the fall, presumably heading for hibernacula. Small-footed Bats, which are common in the arid areas of south eastern Alberta and south western Saskatchewan, may hibernate in these areas if deep enough rock crevices are present (Schowalter and Allen 1981).

Hibernating bats put on fat during the late summer and early fall and begin hibernating in late August or September. During the seven to eight months of hibernation, individuals periodically (every four to six weeks) arouse briefly to urinate and move position within the hibernaculum. However, they must survive on the fat reserves they start with in the fall as no feeding takes place. Undisturbed hibernation sites are thus crucial in preserving bat populations (see Brigham, this volume).

SUMMER ACTIVITIES

While Hoary and Red Bats are solitary during the summer, with females and their young roosting separately from other such family groups, individuals of the other species are colonial (Table 1). Colonies consist almost exclusively of adult females and their young. The activities of males are poorly documented, although they play no role in raising the young and are likely nomadic, roosting alone or in small groups in rock crevices, hollow trees, and buildings (Schowalter et al. 1979).

In the prairies, colonies of females form in May and, depending on the species, may consist of anywhere from a few individuals up to several hundred or thousand (as in Little Brown and Big Brown Bats). Natural colony sites include hollow trees (Barclay and Cash 1985) and rock crevices (Tuttle and Heaney 1974). We know more about colonies in buildings, however, and these are known primarily for Big Brown and Little Brown Bats (Schowalter and Gunson 1979, Schowalter et al. 1979). Maternity colony sites offer protection from the environment and predators and are usually warm, thus reducing the amount of energy females and young must spend maintaining a high body temperature (Barclay 1982, Kunz 1982). Adult, and probably juvenile, females return to the same maternity roosts each year and these sites thus again constitute vital resources which need to be protected from disturbance.

REPRODUCTION

For the hibernating species, mating takes place during the fall and winter at hibernacula (Thomas et al. 1979). Females store sperm until they leave hibernation in the spring, at which time fertilization takes place. Nothing is known regarding the timing of mating in migratory species although females arrive in the prairies already pregnant. Births for all species occur in June and early July, depending to some degree on spring weather since cold, wet conditions cause pregnant females to enter torpor thereby delaying parturition (Racey 1973).

The reproductive rate of all bats is extremely low and most species produce only a single young per year (Table 2). The small litter sizes of bats mean that populations cannot respond rapidly to improved conditions and recovery from population declines is relatively slow, an important characteristic to keep in mind in any conservation effort.

Female bats nurse their own young and recognize them through a combination of olfactory and acoustic signals (Fenton 1985). The young first fly when they are three to five weeks old and virtually fully grown (Burnett and Kunz 1982). For young of hibernating species in particular, the late summer and early fall is then crucial since they must not only learn how to fly and forage, but also must put on fat before entering hibernation. As it is, juveniles enter hibernation significantly lighter than adults and suffer considerable mortality through the winter due to starvation (Keen and Hitchcock 1980, D.W. Thomas, pers. comm.). If they survive their first winter, however, bats have long lives and Little Brown Bats have been known to survive for over 31 years in the wild (Tuttle and Stevenson 1982).

Table 2. Characteristics of prairie bats.

	Mass (g)	Litter Size	Summer Roosts	Diet
Little Brown	8	1	Buildings, Hollow trees	Midges, mosquitoes
Long-legged	8	1	Rock crevices, Hollow trees, Buildings	Moths, dipterans
N. Long-eared	7	1	Trees	Various small insects
Long-eared	7	1	Rock crevices, Hollow trees, Buildings	Moths, dipterans
Small-footed	5	1	Rock crevices	Various small insects
Big Brown	18	1-(2)	Buildings, Hollow trees,	Beetles, other large insects
Silver-haired	11	2	Hollow trees	Midges, mosquitoes
Red	13-16	1-4	Foliage	Moths, beetles, dipterans
Hoary	25-30	2	Foliage	Moths, beetles

FORAGING AND DIET

All the prairie bats are strictly insectivorous and all capture prey while on the wing. The two long-eared species—Long-eared (*Myotis evotis*) and Keen's Bat (*M. septentrionalis*)—however, are also adept at capturing insects from the ground and vegetation (Faure and Barclay 1992, P.A. Faure, pers. comm.). This provides these bats with an additional source of prey and may allow them to inhabit areas in which strictly aerial hunters are precluded, such as areas where cool ambient temperatures reduce the availability of flying insects (Barclay 1991). Aerial insects are detected using echolocation while prey-produced sounds and/or prey movement are used by the gleaning bats to detect prey on surfaces (Faure and Barclay 1992).

Most of the bats found in the prairies emerge to forage approximately 30 minutes after sunset (Barclay 1985a, 1985b, Saunders and Barclay 1992) and the greatest foraging activity occurs in the following couple of hours. During mid-summer, lactating bats may have several foraging bouts, each lasting less than an hour, with a second peak in activity just before sunrise. At other times, especially when ambient temperature falls below about 15°C, bat activity is low during the middle of the night. For most species, foraging does not occur at ambient temperatures below 10°C or in heavy rain (e.g., Barclay et al. 1988).

Foraging habitats vary considerably within species although there are some clear species differences. The larger bats, big browns and hoaries, are fast fliers and forage in open areas above fields, trees, or bodies of water (Barclay 1985b, Brigham and Fenton 1991). Agricultural areas are favoured by hoaries in at least some areas (Barclay 1985b, 1989). The smaller species are more manoeuvrable and can forage closer to the ground or to obstacles such as trees. Little Brown Bats are especially common foraging low (< 1 m) over calm bodies of water where insects tend to be abundant (von Frenckell and Barclay 1987, Saunders and Barclay 1992). Availability of water may thus restrict the distribution of this species and conservation of sloughs and small creeks is likely important in maintaining Little Brown Bat populations. The long-eared species forage primarily amongst trees and other vegetation, presumably due to their gleaning habits (Barclay 1991). Street and yard lights in rural areas can be focal points for bat foraging activity due to the aggregations of insects around the lights.

The diet of prairie bats also varies considerably (Table 2) and most species take a wide range of prey (Barclay 1985b, 1991, Brigham and Saunders 1990,

Saunders and Barclay 1992). Little Brown Bats consume large numbers of dipterans, including mosquitoes, due to their habit of foraging over water (Barclay 1991, Saunders and Barclay 1992). Moths are a common dietary item of many species (Table 2), while big browns and hoaries have large, powerful jaws and include many beetles in their diet (Barclay 1985b, Brigham and Saunders 1990).

Since bats probably consume whatever insects are available, within certain size limits, in agricultural areas pest species that fly at night are undoubtedly subjected to considerable predation pressure if bats are present. Even non-reproductive bats consume up to one-half their own mass in insects per night. For a Little Brown Bat this would amount to approximately 400 mosquito-sized insects! During lactation, it is estimated that a female must consume more than her own mass per night to keep up with the demands of her young (Barclay et al. 1991). The potential for bats to act as insect-control agents is thus immense, and even moderately sized colonies may consume tens of thousands of insects per night. Just the presence of bats may reduce the abundance of some pest species. Many moths, for example, have ears that detect the echolocation calls of bats, causing the moths to move out of the area. Experiments demonstrated that playing bat-like sounds over corn fields reduced the abundance of corn borers because the adult moths avoided the experimental fields.

CONCLUSIONS

Although the above information might give the impression that we know a lot about the biology of prairie populations of bats, the opposite is true. Most of our information on North American bats comes from a few species studied almost exclusively in eastern Canada and the United States. Although the prairies have some of these same species, the unique aspects of prairie habitats and climate undoubtedly have profound influences on many aspects of bat biology. Big Brown Bats, for example, have twin young in eastern North America but primarily single young in the prairies (Schowalter and Gunson 1979). Roost sites, diets, and foraging behaviours all vary geographically within the same species (e.g., Barclay 1985b, Brigham and Saunders 1990, Brigham 1991). The bottom line is that we can not assume that what applies to eastern populations or species necessarily applies to prairie populations or species. The following are some of the key pieces of information we still require if we are to make educated decisions regarding prairie bat conservation.

1. Information on where prairie bats hibernate, or at least what their seasonal movement patterns are, is needed to delineate the geographical boundaries within which prairie populations exist. Conservation only in the prairies during the summer may be futile if disturbance to hibernation sites goes unnoticed.

2. The natural roost sites of most species are virtually unknown. Older trees with hollows or other large crevices may be required for some species, for example, while rock crevices may be important for species such as Small-footed Bats.

3. We have virtually no information regarding the population densities of the non-colonial species. We need to know what proportion of those that migrate into the area actually stay to breed rather than continuing north. The habitat requirements of these species are also poorly documented.

4. Information regarding Small-footed and Long-eared Bats is particularly lacking. Summer roost site and hibernation site requirements, breeding biology, and foraging habitats all need to be better understood before we can attempt to implement logical conservation plans.

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RABIES IN INSECTIVOROUS BATS IN THE PRAIRIE REGIONS OF CANADA

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Rabies is one of the oldest recorded diseases. As early as 322 B.C., Aristotle described clinical signs in humans and dogs that undoubtedly are those of rabies infections. It is an acute infectious disease of the central nervous system caused by a virus, *Formido inexorabilis*, which can infect all warm-blooded animals. Rabies has a worldwide distribution and is absent only in a few islands or island continents. There are very few documented cases of survival of infected individuals of any species, that is, all infections are likely to be fatal. Transmission of the virus generally requires direct contact between infected and uninfected individuals, often by biting. Because of its potential impact on human health, agriculture, and economics, all verified cases of rabies in Canada must be reported to the federal Department of Agriculture.

It is within the above context that rabies has become one of the most feared but also misunderstood diseases. Overlay this with a general perception of fear and misunderstanding of bats and it is easy to see why many of the concerns and attitudes towards rabies in bats are out of proportion to reality.

Tbis paper will provide a general overview of the disease as well as its known prevalence and distribution in insectivorous bats in the prairie regions of western Canada. Data were gleaned from the literature and from the files of Agriculture Canada to cover the time period from 1968 to 1989. Concerns and precautions with regards to human infections are presented. Public awareness is the key to maintaining perspective on the disease and its hosts.

Rabies was first recorded in Canada in 1819 when the Governor General of Canada was bitten by his pet dog (or fox?) and subsequently died of rabies (Tabel et al. 1974). There were few reports of rabies in Canada prior to 1900; however, the number of cases increased steadily through the early 1900s. These cases primarily involved domestic dogs and a few wild canids. Concerted efforts to control the disease in the late 1950s and '60s essentially eliminated infections in domestic dogs. Currently, virtually all rabies in Canada is maintained in wildlife reservoirs.

Insectivorous bats, that is, those bats which feed exclusively on insects, are one of the wildlife reservoirs of rabies. The disease was first identified in insectivorous bats in 1953, although it is likely the virus had been overlooked for many years (Baer 1975). Since then it has been identified in 30 of 39 bat species found in North America (Constantine 1979) and in most provinces and states. However, the pattern of infection and transmission of the virus appears to be distinctly separate from that in terrestrial species (such as skunks and foxes). As an extreme example, a few cases of rabies in bats are recorded each year in British Columbia, yet rabies is not established in any terrestrial species within the province (Pybus 1986a). In contrast, 2000 to 3000 cases are recorded annually in Ontario but, on average, only 30 rabid bats are recorded each year (Agriculture Canada, unpublished data).

While rabies in terrestrial species tends to sweep through susceptible populations in successive waves, rabies in insectivorous bats is much more localized and often is restricted to individual solitary bats or a few infected individuals in a colony. Transmission may occur more often during normal aggressive or grooming behaviours than by an induced hyper aggressiveness as seen in carnivores (Baer 1975). Refined techniques of monoclonal antibody tests can distinguish bat sources of virus from terrestrial sources of virus (Smith et al. 1990) and further support the suggestion that rabies cycles independently in bats, with very little overlap with the virus in other species.

Rabies has been identified in bats in each of the three prairie provinces (Table 1). Similarly, it is enzootic (occurs naturally) in bats throughout Canada (except the maritimes) and in many states in the United States. The pattern of infection appears similar throughout North America: a few infected individuals are reported each year in most areas; infected individuals often are distributed widely; the majority of cases are reported June through September, with a preponderance in August and September; and a variety of colonial and solitary species are involved (Constantine 1967, Schowalter 1980, Pybus 1986a, Rosatte 1987).

Table 1. Prevalence of rabies in bats submitted by the public in the prairie region of Canada from 1968 to 1989.

	Percent infected (sample size)		
	Alberta	Saskatchewan	Manitoba
1968-1977	4.6 (1842)	6.2 (421)	5[a]
1978-1984	4.0 (1347)	3.5 (661)	2[a]
1985-1989	2.9 (1075)	5.0 (760)	1 (47)

[a] Number of infected bats (sample size not available)

In the prairie provinces, an average of ten to twelve rabid bats are recorded each year. Big Brown Bats (*Eptesicus fuscus*), make up the highest proportion of rabid bats (50-60%); however the rate of infection is relatively low (5-10%) (Pybus 1986a). This species often uses maternity roosts (summer colonies) in buildings shared with people and therefore is likely to be seen and collected. Big Brown Bats also are the only species to hibernate in buildings in the prairie region. Normally, hibernating bats are hidden from public view; however, in periods of rapid temperature changes (either increasing or decreasing), conditions within buildings may become unsuitable and Big Brown Bats become active and seek other sites to sleep. At this time they may be seen by the public and submitted for rabies testing.

Little Brown Bats (*Myotis lucifugus*) are by far the most common bat species throughout the prairie regions. This species uses maternal colonies in a wide variety of buildings and they are the bat that people are most likely to see in houses, in barns, along rivers and streams, and around most lakes and sloughs (Pybus 1986b). They also are the species most likely to be submitted for rabies testing and yet they are the species least likely to be rabid (Constantine 1967, Schowalter 1980, Pybus 1986a).

We know very little about rabies in solitary forest-dwelling species of bats. Hoary Bats (*Lasiurus cinereus*), Silver-haired Bats (*Lasionycteris noctivagans*), and Red Bats (*Lasiurus borealis*) migrate north across the prairies in late spring/early summer, spend the summer in deciduous and conifer cover in the aspen parkland and boreal ecoregions, and then cross the prairies again in August and September (van Zyll de Jong 1985). As such, they are rarely seen by people and thus, infrequently submitted for rabies testing. About all we can say is that some rabid individuals of these species are recorded.

One of the major problems associated with understanding rabies in bats concerns bias in the sample. Normally, bats are inactive and inconspicuous during daylight hours and rarely are seen. However, bats submitted for rabies testing usually are collected during the day. Many of these bats are found on the ground, making much noise, and unable to fly. They are perceived by the public as being sick or wounded (often by pet cats) and submitted to Agriculture Canada for rabies testing. The behaviours of these bats are not normal and the sample is unlikely to be an accurate reflection of the infection rate in the population of bats as a whole. Random samples of bats collected within roosts indicate a much lower prevalence of the virus. Rabies was detected in only one of over 2000 bats collected during surveys by Alberta Fish and Wildlife (Pybus, unpublished data).

People should be warned not to handle bats, similar to the warnings against handling any wild animal. Bats found on the ground should be removed (without handling them directly) in order to prevent them from being picked up by a child or a pet. This is accomplished easily by wearing gloves or by using a stick to push the bat into a container. Once collected, such bats should be submitted to a veterinarian or wildlife officer along with a request to have the animal tested for rabies.

Although humans are susceptible to bat rabies, there are very few cases of infection: in Canada, only 21 cases of fatal rabies infection in humans have been recorded. Of these, only 3 were associated with rabies from bats. However, medical precautions should always be taken when there is any suggestion that someone may have contacted a rabid bat.

Anyone bitten by a bat should contact a physician as soon as possible. Also, if possible, collect the bat so it can be submitted for rabies testing. If the bat is

collected and if the bat does not have rabies, no further action is warranted. But if the bat does have rabies, post-exposure vaccine will be administered. The treatment involves up to five intramuscular injections into the arm, similar to getting flu shots. If the bat is not collected, the physician will advise that the immunization shots be given as a precaution, even though the chances of the bat actually having rabies are very low.

With appropriate precautions when handling wild animals and with the availability of pre-exposure and post-exposure immunization, rabies infection in humans can be avoided. However, if these steps are not taken and an infection becomes established in the central nervous system, rabies remains a fatal disease. Thus, the bite of any wild animal should be treated seriously.

Our concerns and fears of rabies in bats appear to stem from early information about rabies in vampire bats in the tropical regions. The prevalence of rabies in haematophagous species (blood-feeding species) is considerably higher than that in insectivorous species. The most constructive thing we can do for the conservation of bats in prairie regions, or in any habitat, is to dispel the fear and concern that the public has for bats and for rabies. This is entirely in line with goal #9 of the Prairie Conservation Action Plan (World Wildlife Fund 1988).

Public information regarding bats should focus on the fact that all bats are not the same and that the species present in the prairie regions of Canada are integral and beneficial elements of the ecosystem (see articles by Barclay and Brigham, this volume). The data summarized in this paper indicate that rabies is an uncommon infection in prairie bat species. Even bats which are acting abnormally are unlikely to be infected with rabies.

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THE IMPLICATIONS OF ROOST SITES FOR THE CONSERVATION OF BATS

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Although it should go without saying that the conservation of all prairie species is important, further justification is often required to convince the general public that bats should not be exterminated as pests. All nine species that occur in the prairie provinces are insectivorous and thus are important natural control agents of agricultural pests and biting insects, including mosquitoes (see Barclay this volume, Fascione et al. 1991). To satisfy their high metabolic rates (Kurta et al. 1989), insectivorous bats have voracious appetites resulting in the consumption of flying insects representing 50-100% of the bat's body mass nightly (Barclay et al. 1991)! Depending on the size of specific insect prey, this may mean between 600 and 1200 insects consumed by an individual bat on one night.

As for any species, the conservation of bats is only possible if the critical habitats and resources they depend on are protected. Bats depend on areas to forage and places to roost, and for some species, the proximity to standing water also seems to be important. For the purpose of this paper, I will concentrate on roost sites, since these sites are generally specific to bats. Foraging habitats used by bats are so diverse that discussing them in general terms is virtually impossible and the foraging flexibility exhibited by bats suggests that identifying specific sites would be difficult (e.g., Brigham 1991). Further, from a conservation standpoint, roost sites are vulnerable in that people represent the major threat to bats in these locations. Thus education can have a major impact on the protection and long term survival of these mammals (Tuttle 1988).

For the six prairie species which are year round residents (Big Brown Bat [*Eptesicus fuscus*], Little Brown Bat [*Myotis lucifugus*], Western Long-eared [*M. evotis*], Western Small-footed Bat [*M. ciliolabrum*], Northern Long-eared (Keen's) Bat [*M. septentrionalis*], and Long-legged Bat [*M. volans*]), two different roost sites are required during the year; one for hibernation during the winter and one for summer maternity colonies. The critical summer roosting sites for prairie populations of migratory bats (Hoary [*Lasiurus cinereus*], Red [*L. borealis*], and Silver-haired [*Lasionycteris noctivagans*]) are likely most common in riparian forest. It is probable that the maintenance of introduced trees in urban areas and as windbreaks has helped these species considerably, however, there is little data on the effect of urban environments on these migratory bats.

HIBERNATION SITES

Hibernating bats arrive at hibernation sites in autumn (late July to November). Prior to entering hibernation, bats must accumulate up to 40% of their summer body mass as fat to use as an energy supply throughout the winter. If these reserves are depleted before warm spring weather and the emergence of flying insects, the bat starves. Bats seem to select hibernation sites on the basis of temperature and humidity, but the precise means by which they do this remain unknown (e.g., Nagel and Nagel 1991, Tuttle 1991) and each species has its own optimal conditions. The site must be cool enough to allow metabolism to remain low, yet warm enough to prevent freezing. This generally means a range between 0° and 10°C. Moisture in the form of humidity may be even more important than temperature to hibernating bats. Natural arousals, which probably account for 80-90% of the total drain on fat reserves through the winter are mediated by water loss (Thomas et al. 1990). Bats occupying more humid sites should be able to remain torpid for longer periods than animals in dry sites.

Where prairie bats hibernate is mostly a mystery. It is known that Big Brown Bats can hibernate in buildings that offer the right conditions (Brigham 1987). However, in most cases bats use abandoned mines, natural caves, or deep rock crevices. In all likelihood, most prairie bats must migrate to find these sites (Schowalter 1980). It may be that much of the fall migration is northward to the Canadian Shield, where potential sites are likely more common. Regardless of the migration destination, it is clear that we cannot fully protect prairie bats by focusing only on prairie sites. We must retain a broader geographical perspective.

Bats are most vulnerable during hibernation, yet protecting them at this time is relatively simple. The most

frequent problem is human disturbance at hibernatiou sites. Requiring up to an hour to arouse when disturbed, bats cannot fly away from danger and vandals can easily destroy hundreds or thousands at sites with large numbers. Even more unfortunate are the results of inadvertent disturbance by cave/mine explorers who are unaware of the effects they have on bats. It is well documented that human entry into a hibernation site causes many bats to arouse. Each time a Little Brown Bat arouses, it expends sufficient body fat to have lasted for 67 days of uninterrupted hibernation (Thomas et al. 1990). Thomas and his colleagues estimate that three extra arousals beyond the normal number can cost a Little Brown Bat its life. The simple solution is to prevent human access to hibernation sites during the winter. It is fine to enter these sites in the summer when they are not used by bats. We also need to reconsider the strategy of using explosives to blast old mines shut for safety reasons. Caves or mines can be gated in a way that allows bats to come and go but keeps people out (Thorne 1990). Gating allows bats to continue to use sites, solves the safety problem, and, in the case of caves, can also restrict human access at certain times (e.g., winter) of the year. As usual, the best prevention is through education. People who are informed of the inadvertent harm they may cause wildlife will almost invariably cease the activity causing the problem.

SUMMER MATERNITY ROOSTS

The second essential roost habitat required by bats is a summer roost. These sites are essential to provide shelter from predators and inclement weather but, most importantly, to provide the appropriate environmental conditions for raising young. Bats have been documented to use every conceivable type of shelter including: trees (hollows, under bark, in foliage), rock crevices, animal burrows, abandoned mines, and buildings (Kunz 1982). Prairie bats are most often found roosting in hollows (trees, buildings; Schowalter and Gunson 1979, Barclay and Cash 1985) or the foliage of trees (Barclay 1984). Hollows tend to be exploited by female *Myotis* and *Eptesicus*, species that congregate in large maternity colonies to bear and raise young. These sites are likely limited in number and are especially vulnerable to human disturbance. Roost temperatures tend to be extremely high (often 35°C in the daytime), a characteristic that promotes the rapid growth of baby bats. For most species, we have little knowledge of the summer roosting activities of male bats, but they likely roost solitarily or in small gronps. Foliage roosting species such as Hoary and Red Bats are solitary, roosting singly or in small family groups comprised of a female and her young (van Zyll de Jong 1985).

Unless disturbed, there appears to be a strong degree of loyalty to roosting sites (both summer and winter) with individuals exploiting the same sites for many years (Brigham and Fenton 1986). This should increase our incentive to protect tree hollows and cavities that are known to be used by bats. However, the use of buildings as roosts, especially by Little Brown and Big Brown Bats, often brings bats into direct conflict with people. Large numbers living in the attic of a house is a nuisance that many people will not tolerate. Most colonies are small and particularly in well insulated buildings, may remain undetected for years. When guano accumulation, odors, or noise from large colonies necessitate a remedy, eviction and exclusion is the only safe, permanent solution (Barclay et al. 1980, Brigham and Fenton 1986, Saunders 1990). Lights, noisemakers, ventilation, and various chemicals including mothballs are simply not effective (Hurley and Fenton 1980, Laidlaw and Fenton 1971). In fact, poisons usually create worse problems than those they are meant to solve. Poisoning increases the chance of contact between hats and people and weakened bats may be more susceptible to diseases such as rabies (see Pybus, this volume). Further, any poison that kills or disables bats will likely be detrimental to human health. Exclusion eliminates the problem, but does not kill the animals. Killing is strongly discouraged both because it is unnecessary, but also because it is not a permanent solution to the problem. Unless the access areas used by bats are closed off, the building will likely be recolonized in the near future.

If bats must be excluded from a building, the first step is to determine the access site(s). By watching the building at dusk as the bats exit to feed, they will "show" how they are getting in and out. Close inspection during the daytime will reveal the holes or cracks (often less than 1 cm wide) being used. Once the exits have been located and the number of bats that emerge counted, bats can be excluded by sealing cracks with screening or other light building materials (Barclay et al. 1980). Unlike rats and squirrels, bats cannot chew their way through these materials. Ideally the access points should be sealed in winter when the bats have left the structure to hibernate (generally October to April). If it is necessary to exclude bats in the spring or fall, do so only after all the bats have left the roost at night to feed. Do not close off openings from mid-June until the end of August as this is when flightless

young are present and excluding mothers will result in the death by starvation of the young.

Bats are very adept at finding and using alternative entrances to a preferred roost and it is important to seal all potential access points (Brigham and Fenton 1987). Presumably, bats select particular buildings because of the optimal conditions they provide; therefore, it is not surprising that they will be persistent in their efforts to gain access. Finally, before attempting exclusion, warn your neighbours. For excluded Big Brown Bats at least, the animals often take up residence in the nearest structure, meaning your neighbour's house (Brigham and Fenton 1987).

It is possible to invite bats to your neighbourhood and enjoy the positive aspects (e.g., insect control) without having to share your house with them. Bat houses are becoming more popular in North America and can be constructed or purchased for a modest cost. Plans for a bat house developed by Matthew Saunders (Bat Check, Box 1243, Kingston, Ontario K7L 4Y8) are shown in Figure 1. Saunders also sells these structures preconstructed. Plans and preconstructed bat houses can also be purchased from Bat Conservation International (Box 162603, Austin, Texas 78716). Factors critical for the success of these houses include: their size and shape, roughness of roosting surfaces, and the distance from foraging areas. All inner surfaces should be rough or horizontally grooved to ensure that bats can get a foothold. Avoid using chemically treated lumber as many wood preservatives are toxic to bats. Do not paint, stain, or varnish the structure because odors from these coatings will discourage bats. Mount the house three to six metres above the ground on south facing aspects in areas that offer some protection from the wind. Bat houses near water are probably most likely to be successful.

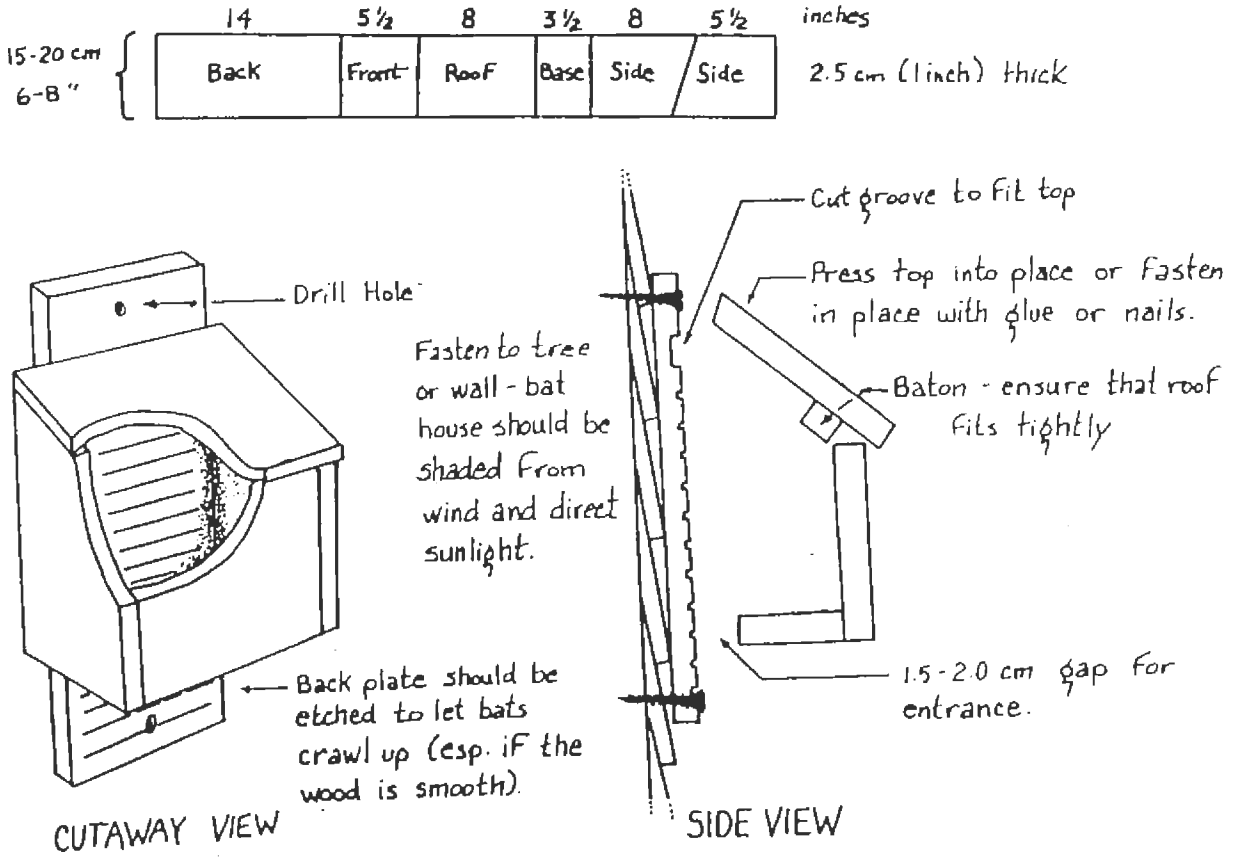

Figure 1. This small bat house may house up to 30 bats at a time. It can be modified to hold more bats by increasing the width of the board and using the same dimensions for the other parts. Other designs can be used, but the best designs have an entrance no more than 2.0 cm wide and no longer than about 15 cm from side to side. If the distance between the back and front of the house is increased, include a dividing wall in the centre. Bats prefer relatively cramped space and the divider will increase the capacity.

Finally, be patient, most bat houses are not occupied for a least a year and sometimes only after two or three years. As with bird houses, some are never occupied for one reason or another. One strategy that seems to work is to put up bat houses at the same time as the exclusion of a colony from a nearby building is attempted. The bat houses become a readily available alternative roosting site.

In conclusion, I hope I have illustrated that we really can do something to protect and conserve the bats that are found in the prairies. Usually some simple information and eduction will make all the difference. Although it is perhaps overly optimistic to expect the majority of people to become "bat lovers," it should be possible to achieve a situation where no one will cause intentional harm and we can prevent the unintentional damage due to a lack of information. This is probably the greatest threat to bat populations.

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AN UPDATE ON THE SWIFT FOX REINTRODUCTION PROGRAM IN CANADA

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INTRODUCTION

The Swift Fox (*Vulpes velox*) Reintroduction Program began as a private project when Miles and Beryl Smeeton established a wildlife reserve near Calgary, Alberta and imported two pairs of Swift Fox from Colorado, United States in 1973. This parent stock subsequently bred and raised young and from these beginnings grew a project that developed into a major program involving four university/federal/provincial groups (Canadian Wildlife Service [CWS], Alberta Fish and Wildlife [AFW], Saskatchewan Natural Resources, University of Calgary) and numerous non-government organizations (Calgary Zoo, Wildlife Reserve of Western Canada [WRWC], Moose Jaw Wild Animal Park, Edmonton Valley Zoo, Swift Fox Conservation Society, World Wildlife Fund [WWF], Petro Canada, Esso Resources, Canadian National Sportsman Show, Elsa Foundation, Grant McEwan Nature Foundation, Canadian Automobile Association). Earlier results of the Swift Fox program were summarized in this conference series (Herrero et al. 1991) and by Scott-Brown et al. 1986.

The CWS first became involved in 1978 when COSEWIC (Committee on the Status of Endangered Wildlife in Canada) classified the species as extirpated in Canada. From 1984 to 1989 the project was guided by a technical committee, which was replaced in April 1989 by a recovery team under RENEW (Recovery of Nationally Endangered Wildlife).

The mandate of the recovery team was to carry out a 3-year experimental program with the main objective being, "Is it feasible to reintroduce the Swift Fox back into the Canadian prairies." This objective has been approved by the Committee of Wildlife Directors of Western Canada (WDWC). When the recovery team was established it had available to it a wealth of information, obtained over the years by lengthy "trial and error research." It is important to recognize that without this field data, none of the information we now have on the responses of the foxes to different release techniques or environmental conditions would have been available. This database has stimulated new ideas which needed to be explored.

From 1983 to the fall of 1987 all releases of mainly captive bred foxes had been done by the soft release technique, i.e., holding foxes over winter in pens and releasing them the following spring or summer, whether they had successfully bred in the pens or not. In the fall of 1987 the first hard releases were attempted; releasing foxes directly into the natural prairie landscape (Carbyn et al., in press).

About 30% of all Swift Fox releases were radio collared in both hard and soft releases. Survival data was obtained. The program was expanded to include: 1) releasing more wild trapped foxes and comparing their survival with captive bred individuals; 2) releasing foxes in the spring rather than the fall to determine which time frame gives better survival; and 3) diversify release locations, choosing a release area which has more moisture and better habitat as a hedge against drought which had occurred in 1988 at the main release location.

After the 3-year experimental program, the data was evaluated to determine if reintroduction is feasible and to provide recommendations to the WDWC as to whether a full scale recovery program is possible (Carbyn et al. 1991).

SOURCES OF FOXES

Two sources of Swift Fox are available for reintroduction: captive bred and wild trapped from the United States.

Captive Bred

Four breeding facilities are producing Swift Foxes for release in Canada. They are: 1) WRWC, renamed in 1991 to Cochrane Wildlife Reserve, near Cochrane, Alberta; 2) Calgary Zoo, Calgary, Alberta; 3) Edmonton Valley Zoo, Edmonton, Alberta; and 4) Moose Jaw Wild Animal Park, Moose Jaw, Saskatchewan.

Cochrane Wildlife Reserve currently has 25 pens in use and can produce 60 to 90 young Swift Fox annually. Calgary Zoo houses 4 to 5 pairs and produces 15 to 20 foxes per year. Moose Jaw Wild Animal Park has 5 breeding pens and produces 15 to 20 foxes per year. Edmonton Valley Zoo has one display pair and produce 3 to 5 young yearly for the release program.

Wild Trapped from the United States

Swift Fox populations exist in substantial numbers available for trapping as far north as central Wyoming. From 1973 to 1991 a total of 107 Swift Fox have been imported from the United States. The breakdown by state is as follows: South Dakota - 13; Wyoming - 52; Colorado - 42. Excellent cooperation has been obtained from the Wyoming Game and Fish Department in 1990 and 1991.

RELEASE SITES

Totals released at various release sites are summarized in Table 1.

Border Area

The Alberta/Saskatchewan border area has a continental prairie climate characterized by cold, harsh winters, warm summers and low precipitation. The mean yearly precipitation is 340 mm (range 260 to 380 mm). The Short Grass Ecoregion has the warmest summer temperature in Alberta. The mean May to September temperature is 15°C (range 14.5 to 16°C). Winters are characterized by cold temperatures and relatively little snowfall. The mean December to February temperature is -10.5°C. The combination of low temperatures interspersed with warm thaws and little snow cover results in harsh winter conditions for vegetation.

The terrain of the area is generally flat to rolling except where bisected by numerous coulees and run-off channels. Elevations average approximately 1,000 m above sea level. Major habitat types in the study area include uplands, coulees, and badlands. The predominant vegetative association of the upland types is the Spear Grass (*Stipa comata*)-Blue Grama (*Bouteloua gracilis*) association. Vegetation in the coulee areas is variable. Slopes may be eroded or grassy, shrubs such as willow (*Salix* spp.), and Saskatoon (*Amelanchier alnifolia*) may be present. A Western Cottonwood (*Populus deltoides*) association is found in the Milk River Valley. Badland habitats are generally devoid of vegetation and only hardy species such as Greasewood (*Sarcobatus vermiculatus*), sagebrush (*Artemesia* spp.), prickly pear cactus (*Opuntia* spp.), Winter Fat (*Eurotia lanata*), and Salt Sage (*Atriplex nuttallii*) can survive (Reynolds 1983).

Although there are cultivated areas (hay and wheat fields) within the release area the primary land use is ranching. The area is generally remote and contains few inhabitants. The area is roughly circumscribed by: Cypress Hills to the north; Montana border to the south; Manyberries to the west; and Consul, Saskatchewan to the east.

Milk River Ridge (Knight/McIntyre Ranches)

This release area is located in southwestern Alberta roughly between Magrath to the north, Del Bonita to the south, Milk River to the east, and Cardston to the west. The elevation of the Milk River Ridge ranges from 1000 m in the east to approximately 1400 m to the west. The climate is considered to be inland continental characterized by cold winters and warm summers. Precipitation (500 to 550 mm) is almost double that of the Alberta/Saskatchewan border area. The Milk River Ridge is an area of transition from the mixed grass prairie to the fescue prairie of the south western foothills. In coulees and protected moist areas shrubs such as willow, rose (*Rosa* spp.), Silver-berry (*Elaeagnus commutata*), and Thorny Buffalo-berry (*Shepherdia argentea*) occur.

Table 1. Summary of the numbers, location, and number of radio collared Swift Foxes released during hard release programs in southern Alberta and Saskatchewan.

Year/Season of release	Summary of hard releases - 1987 to 1991					
	Alta./Sask. Border		Wood Mountain		McIntyre	
	# Released	# Collared	# Released	# Collared	# Released	# Collared
Fall 1987	57	18	-	-	-	-
Fall 1988	53	12	-	-	-	-
Spring 1989	-	-	-	-	28	14
Fall 1989	35	13	-	-	33	13
Spring 1990	28	27	-	-	-	-
Fall 1990	38	0	51	20	-	-
Spring 1991	-	-	29	28	-	-
Fall 1991	35	0	46	10	-	-
Site Total	246	70	126	58	61	27
Hard releases					433	
Soft releases					136	
Total					569	

This release area was chosen during a period of drought on the prairie. Higher moisture levels on the Milk River Ridge made it an appealing choice. Releases were discontinued in 1989 when a rabies outbreak occurred in the Striped Skunk (*Mephitis mephitis*) population and Alberta Agriculture had to set out a poisoning program to reduce threat of spreading the disease.

Wood Mountain

The Swift Fox release areas were selected after examination of potential sites across southern Saskatchewan and Alberta. The primary requirements sought were areas of continuous prairie of at least 500 to 800 km^2 and a population of American Badgers (*Taxidea taxus*) to provide holes. Prey abundance, moisture conditions, and winter severity were also considered when looking at possible review sites.

In Saskatchewan, the Wood Mountain area, the border area south of Cypress Hills, the Matador area and the Missouri Coteau near Old Wives Lake, and the area near the Great Sandhills were examined. Only the Border and the Wood Mountain area were judged large enough and suitable terrain for Swift Fox release. The release area is between the East Block and the West Block of Grasslands National Park, this offers some degree of permanency that the area will remain natural grassland habitat.

RESULTS AND DISCUSSION

Survival and Monitoring

From 1987 to 1991 there were 155 radio collared foxes hard released on the three release areas (Table 1). Since 1988 there were 33 wild (United States) Swift Foxes (captured in Wyoming or Colorado and translocated) hard released in Alberta and Saskatchewan. Since 1987 there have been 122 radio collared captive raised foxes hard released in Saskatchewan and Alberta. Of the 122 radio collared hard released captive raised foxes 41 were released in the spring, and 81 were released in the fall.

During the first six months post release, the captive raised fall released foxes survived significantly better than the spring released captive foxes. At the end of the twelve month period fall and spring released captive raised foxes had similar minimum known survival rates. Although the sample size is small for wild (United States) foxes released in the fall there is no

obvious difference in minimum survival rates between spring and fall releases. It is clear that regardless of which kind of fox is released or when, it is the first three months that are the most critical. From three months to nine months the survival slopes of the spring released captive foxes and the wild (United States) foxes are almost identical except they have stabilized at different levels. This indicates that these two groups have probably developed similar survival mechanisms after the first three month adjustment period. The fall released captive raised foxes show a steep drop in survival for the first three months but stabilize at a higher level than spring released captive raised foxes, however, the decline to twelve month period is steeper than any other group. This appears to be a result of possible better conditions in the fall and foxes released at that time probably face more favourable conditions from September through November but are then presented with the rigors of winter. By the time winter sets in, those that have survived, will have found protective cover and a knowledge of their hunting terrain. These fall released foxes also display another slight drop in survival during the spring of the following year which puts them at a similar level of minimum known survival as spring released captive raised foxes at the end of twelve months.

When the data from 21 foxes wild born on the study area, wild (Canada), are included there is, as expected, no steep drop in the first three months after capture and the survival rate declines steadily over a 12 month period. At the end of 12 months the minimum known survival of the wild (Canada) foxes is actually lower than the wild (United States) translocated foxes. This may be due to the combination of juveniles and adults of various ages in the wild (Canada) component. The wild (United States) foxes were all a minimum of one year old when released and old foxes were imported for release to the study area.

There may be several explanations for the differential survival of fall and spring released captive raised foxes. The captive raised foxes released in the fall are mostly young of the year (five to six months old) compared to the spring released foxes which are all at least twelve months old. The young foxes may be much more flexible behaviourally, learning to capture prey and avoid predators earlier than the older foxes. The other main factor, which is not unrelated to the first, has to do with prey abundance and availability. For example, in the fall of 1987 there was tremendous abundance of grasshoppers. Captive raised foxes shortly after being released, were observed capturing grasshoppers. Field observations of scat contents revealed a very high percentage of grasshopper parts. As the foxes gained experience in hunting, the proportion of grasshoppers decreased and small mammal content of the scats increased. It is therefore, probable that the easily available grasshoppers provided both nourishment and learning experience for the young foxes. Foxes released in the spring do not have this opportunity and although there may be an abundance of other food sources they may not be available to an inexperienced fox. The most abundant source of prey in the spring in the Saskatchewan/Alberta release area would be young ground squirrels which are not very difficult to capture. However, Richardson's Ground Squirrel (*Spermophilus richardsonii*) distribution in the area is very spotty and may be unavailable to foxes inexperienced at catching them, also ground squirrels are not nocturnal. Foxes which hunt ground squirrels during the day are probably more exposed to predation.

Survival of Captive Raised Versus Wild Caught Foxes

Experimental releases using captive raised and wild caught foxes were simultaneously released in the spring (May) 1990 and spring (May) 1991. In the first release 14 and 13 foxes, respectively, were let go on a hard release. In 1991, 14 foxes from wild caught and captive raised groups, were released in a similar experiment. In both years, all foxes released were radio collared and movements monitored at regular intervals.

The experiment clearly indicated that survival of wild caught foxes was superior to captive raised foxes. Five out of 27 (19%) of the captive raised foxes were known to be still alive after three months. Seventeen out of 28 (61%) of the wild caught foxes were alive after three months post release. Six months after the release, 15% of captive raised foxes and 50% of wild caught foxes were still alive and after nine months figures were 7% and 43% respectively. In this experiment all captive raised foxes were young of the year, while wild caught foxes included all age classes.

This experiment did not test survivorship statistics of fall released wild foxes with fall released captive raised foxes. Not enough is known about whether or not foxes captured in late summer are old enough for release in fall, prior to when harsh weather conditions set in. After capture and transport from the United States to Canada, there is always a 30-day quarantine period to deal with. In any case, if spring conditions

are less suited than fall conditions and spring released wild caught foxes are superior to fall captured captive raised foxes, then the conclusion that wild caught foxes are superior still is valid. More experimental work would be desirable, if funding were to permit.

Current Status (1991)

The Canadian free roaming Swift Fox population in the winter of 1991/1992 was estimated at a minimum of 225 (range 150 to 300) individuals (Carbyn et al., in press). All of these foxes are believed to have originated from the release program. Of the three release areas the Saskatchewan/Alberta border area has the greatest numbers of foxes. The information from the Milk River Ridge is very limited. Only one natal den was found in 1991 and very little sign observed. More data is needed for this area but we expect that there may be no more than ten or twelve foxes in the Milk River Ridge area.

The Wood Mountain release area is still under investigation. From current information we expect the population there to be less than fifty foxes (D. Hjertaas, in prep.).

The population of 150 to 250 foxes on the border area was estimated by two methods (capture/recapture and saturation trapping). These two methods are not entirely independent. The first method involved the saturation trapping of a township on the Alberta side of the release area. This township was chosen as a representative one (it also had reasonable access). The results were then extrapolated for the roughly 13 townships of what we have described as core range. From satellite photos we estimated there may be as much as 70 townships of potential Swift Fox habitat available. Excluding the 13 townships of core range there are 27 out of 70 for which we have some evidence of Swift Fox occurrence (sighting, radio locations, tracks, or other signs). Although we trapped 11 individual foxes on the township, we know from radio telemetry information that one fox had a home range which was primarily outside the township. From the information we feel an average density of eight per township for the 13 townships in the core area would be more appropriate. This gives an estimate of 104 foxes. The 27 townships surrounding the core may have a density of four foxes per township for an estimate of 108 foxes. We have virtually no information for the remaining 30 townships. However, given the information we have on dispersal we estimate a possible density of one fox per township. The total estimate is 242 foxes for the Saskatchewan/Alberta border area.

The densities on the Saskatchewan/Alberta border appear to be somewhat similar to densities in Wyoming as reflected by trapping success (Table 2). The overall 11% success in Wyoming is actually lower than for the border area at 13.5%. The slightly higher border area success may be due to us having some knowledge of where to trap certain individual foxes, otherwise techniques were similar. This is a crude comparison and is not meant to indicate that we have a large viable population in the Saskatchewan/Alberta border area, only that for the 13 townships of core range in Saskatchewan/Alberta densities are roughly similar to the Wyoming trapping area.

It seems evident that we have a small population of Swift Foxes established on the Saskatchewan/Alberta border area. On the basis of genetic considerations alone, a population of 50 individuals is adequate for the short-term survival of most species. However, given environmental stochasticity, especially on the short grass prairies, where environmental condition can be severe, a population of more than 50 may be required for short-term survival. For long-term survival a population of several hundred may be essential to maintain population viability (Mace and Lande 1991).

Table 2. A year-to-year comparison of trap night success of Swift Fox in the Saskatchewan/Alberta area and southeast Wyoming.

Area	Total trap nights	Captures	% Success
Sk./Alta. 1990/91	215	41	19
SE Wyoming 1990	172	19	11
SE Wyoming 1991	205	24	13
Sk. Alta. 1991/92	308	25	8
Sk./Alta. Township	185	11	6

In the broader North American context, Swift Foxes are not an endangered species. Restoration of the Swift Fox to the Canadian prairie landscape has therefore, become symbolic, focusing on the need for protection and restoration of impaired ecosystems. Habitat fragmentation in the great plains region to the south makes dispersal more difficult. Unsubstantiated reports of Swift Foxes within North Dakota, if proven correct, could bring the American population possibly within about 200 or so kilometres of the United States/Canadian border.

Other Potential Release Areas

Throughout the history of the Swift Fox program, release areas have been chosen by evaluating and comparing habitat suitability among potential sites. The earliest releases in the Lost River Ranch area were decided upon after Carlington's (1980) evaluation was refined by Reynolds (1983). Additional releases in the border area and the Knight/McIntyre areas were preceded by habitat evaluations completed by C. Mamo. The Wood Mountain site was chosen after comparison with other potential Saskatchewan sites by D. Hjertaas and W. Harris.

In each of these evaluations, the key factors considered were: size and security of available suitable habitat; prey availability, particularly rodents, grassland birds, and grasshoppers; and den site availability as indicated hy ground squirrel and badger burrows.

Within Alberta, the Swift Fox Recovery Team and experienced field staff believe that additional suitable potential habitat for Swift Fox is available to the north and west. Priority areas are: the Canadian Forces Base (CFB) Suffield, the area between Brooks and Medicine Hat, and the grasslands north of CFB Suffield.

CFB Suffield has been evaluated by Carlington (1980) and Mamo (pers. comm.). In all evaluations this area showed significant potential, with some concern expressed over prey availability (small mammals) and the compatibility of adjacent land use (military exercises). With the recent announcement of the proposed National Wildlife Area with CFB Suffield, this area again shows potential as a future release area. Problems do exist in sections of the CFB leasehold where sand is a predominate soil condition. Such areas may not be suitable for denning.

It is interesting to note that several foxes have dispersed from the existing southeastern release areas to the vicinity of Brooks and Gem, Alberta. Also two reports of Swift Fox seen near Iddesleigh and Ralston are believed to be legitimate. These reports reinforces the assumption that this area may provide habitat which Swift Fox view as suitable.

Assuming the existing Swift Fox program continues and is successful in establishing a resident population throughout available habitat in current release areas, it will be important to identify the potential of additional grassland areas which could support Swift Fox. Over the next five years, the priority blocks should be evaluated, using existing criteria, and compared to proven high quality habitat in the border area. Upon completion of the current program, this data can be used as a key factor to determine if and where additional releases should be undertaken. In future, it may be possible and desirable to simply translocate foxes from a healthy viable population in southeastern Alberta to vacant suitable habitats further north and west.

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Reintroduction programs invariably tend to be associated with high publicity, often high risk ventures producing an extra amount of organizational stress. The human factor becomes paramount and we like to thank the literally "hundreds" of volunteers, participants, and cooperators. Obviously there is not enough space to recognize them all. H. Armbruster, B. Treichel, and K. Sturgess were active and effective field workers. Wyoming Game and Fish Department and their employees were most helpful in the acquisition of wild foxes. D.J. Fitzgerald and John Sharps helped in earlier fox acquisitions. Funding came from CWS, AFW, WWF Canada, Petro Canada, Esso Resources, Swift Fox Conservation Society, Alberta Recreation Parks and Wildlife, Canadian National Sportsman Show, Elsa Foundation, Grant McEwan Native Foundation, Canadian Automobile Association and through the auspices of the Swift Fox Conservation Society, a non-profit organization, funds from literally thousands of school children and other contributors were obtained from an "adopt-a-fox program." We would like to thank M. Regnier for typing the manuscript.

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J. Michie, P. Rhodes, C. Smeeton, M. Smeeton (deceased), and G. Tarry. Ranchers throughout the area were supportive and interested in the project. We want to particularly thank the Moorehead's, Piotrowski's, and the Saville's. The captive breeding program involved employees, volunteers, and enthusiasts from all over Canada and some from Europe and the United States. Staff from captive facilities were involved in various stages. Calgary Zoo staff were supportive in providing veterinarian services and kept records of the captive population.

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A REVIEW OF THE FILM - "LITTLE FOXES OF THE PRAIRIES"

L.N. Carbyn

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INTRODUCTION

In the proceedings of the second Endangered Species and Prairie Conservation Workshop, I reviewed the National Film Board production of "Return of the Swift Fox" (Carbyn 1991). Since then another film produced by TV Ontario and NHK Enterprises Japan originally slated with the same name was released. Upon discussion between the co-producer Janet Foster and myself, the title was changed to "Little Foxes of the Prairies." Even though the message of both films is the same, in my view the quality is not. The second film has been far superior in capturing the essence of the project; a fact that partly reflects the work accomplished in the time between the production of the two films. "Little Foxes on the Prairies" is an exceptional product because it puts the viewer right with the foxes in the prairies.

THE MESSAGE

The Swift Fox (*Vulpes velox*) is a "flagship" species in that it captures the public's attention. Its reintroduction is a project that brings back an attractive mammal to an area where it used to be quite common. The public strongly identifies with the notion of endangered species. The real problem, however, is not that Swift Foxes are an endangered species, because in fact they are not. The species is still quite common in the southern portions of the range. Some time during the 1930s it became extirpated within its northern range. It is, therefore, appropriate to return the species where it belongs, because it adds a "missing link" to the ecosystem.

Fundamentally more important, though, is the protection of mixed grass prairies. This biome has been one of the most threatened areas on the North American continent. In Canada, transformation of native mixed grasslands to farmland involves some 80% of available areas. Only by default, not design, are some 20% of the mixed grasslands still left. These areas are found along heavily eroded, hilly areas (difficult to cultivate) or in very dry regions. Ploughing of native prairies has little impact on the human consciousness. Expressed in another way, unless you are a botanist, people generally do not get "excited" about grasses. For example, in Canada, based out of Calgary, there has existed for years a thriving "Swift Fox Conservation Society" but nowhere in Canada is there a "Native Prairies Conservation Society." Repeated recommendations for a name change from "Swift Fox Conservation Society" to "Swift Fox and Native Prairie Conservation Society" has fallen on "deaf" ears. People do identify with animals—not all animals though. Rats can be poisoned at dumps or granaries without sympathy. Wolves, on the other hand, are dealt with differently. On the prairie, Swift Foxes and Burrowing Owls (*Athene cunicularia*) are two species with great appeal. The common "gopher", i.e., Richardson's Ground Squirrel (*Spermophilus richardsonii*), falls into the "rat category"—poison and destroy it at will, no questions asked. What is needed is a holistic message—protect Swift Foxes, protect grasses, and protect "gophers"—they are all important. This film provides that message.

OBJECTIVITY AND SCIENTIFIC ACCURACY

In dealing with such a charismatic and charming species one could, and should, turn a blind eye to some of the anthropomorphisms, however, they ought to be noted. "Father" fox "Bert" from Colorado is noted as having married a "local girl" and he is a "good father, playful and patient with the kids." A more serious statement is that the adults "teach lessons of behaviour." Much of fox behaviour observed at den sites is genetic or inherited and through trial and error the behavioral repertoire of young foxes is expanded. It is noted that the first foxes ever born in captivity were at the Calgary Zoo. That is not correct. Swift Foxes were bred at several smaller zoos and possibly at a larger zoo prior to the 1970s.

Footage of the Swift Fox playing at the den was delightful and commentary generally appropriate. Little do the viewers know that these shots were taken only a few feet away from the comforts of a vehicle.

IMPORTANCE TO PRAIRIE CONSERVATION

I rate this film exceptionally high in achieving an important goal—telling the story of an important conservation issue—saving the native prairies. The clarity of the message is backed by appropriate images. Well chosen and dramatic are the images of a patchwork of cultivated areas next to native grasslands and Swift Foxes enjoying life to the fullest in untrammelled native prairies. On seeing this film, how can anyone ever say "why spend time and effort in protecting what is left of our native grasslands?"

ARTISTIC IMPRESSION

This film shows only the very best footage. Colour balance is excellent and the images clear and crisp. The quality of photography was very even. Almost all the footage with wildlife in it had the animals completely in the frame, and where the animal was only partially involved, the motion was towards the viewer. The background music was superb and blended well into the narration. An interview with one field investigator comes across flat and stilted. A bit more "spark" would have added to the vitality of the film. Minor criticisms should not detract from the important conclusions. This film is a winner. The producers are to be congratulated for a job well done.

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BLACK-FOOTED FERRET RECOVERY IN CANADA

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ABSTRACT (Schroeder 1992)

The Black-footed Ferret (*Mustela nigripes*) is extirpated in Canada, with the last museum specimen taken near Climax, Saskatchewan in 1937. A total of 20 ferret specimens originate from southwestern Saskatchewan, with one recorded in Alberta but thought to come from Saskatchewan. Decline in ferret populations in Canada and the United States, where they were found in 12 states, is directly associated with early European settlement of the North American great plains region and the corresponding expansion of a farming and ranching economy. The reduction of ferrets was mostly indirect as their primary prey, the prairie dog (*Cynomys* spp.) were directly affected by these agricultural practices through habitat disruption, poisoning, trapping, and hunting. The Black-tailed Prairie Dog (*Cynomys ludovicianus*) population, near Val Marie, Saskatchewan, which would serve as a base for ferret recovery in Canada, is also small and listed as vulnerable.

After the capture of 18 wild ferrets in Wyoming in 1986, a captive breeding program has successfully raised the number to more than 300 in just five years. With a secure source of animals, reintroduction to the wild began in 1991 in Wyoming. In 1992, the Metro Toronto Zoo finished a large ferret breeding facility and is awaiting the arrival of 30 pairs of ferrets. This is part of a strategy to preserve as much genetic diversity of the original 18 wild ferrets as reasonably possible. This recovery plan incorporates the management objectives of the Black-footed Ferret breeding program of the American Association of Zoological Parks and Aquariums.

The purpose of the Canadian recovery plan is to downlist ferrets from extirpated to endangered. To achieve this, a habitat suitability or rating index was calculated for the Val Marie prairie dog complex using dated data to determine if the amount of habitat (prairie dogs) currently available is sufficient. The rating index was calculated to equal 6.68. A rating index of 30 is considered minimal for ferret recovery. The best option for recovery is to expand the existing prairie dog complex at Val Marie by a factor of five, if ferret recovery is to occur at all.

The feasibility of reintroducing ferrets is to be evaluated over a five year period, beginning 1992. Most of the effort should be directed toward censusing the Val Marie prairie dog complex and calculating the habitat rating index annually. At the same time, steps should be taken to improve the prospects for expanding the existing prairie dog population. The Canadian Parks Service, the major landowner of Black-tailed Prairie Dog habitat in the Val Marie district, could make a start by developing a ferret management plan for the proposed national park area. Other landowners will eventually need to become involved through cooperative agreements. After five years of management and monitoring Black-tailed Prairie Dogs, a decision to proceed with reintroduction or continue with prairie dog enhancement is needed.

Public awareness programs regarding the ferret recovery effort and especially an awareness of importance of prairie dog ecology to prairie biodiversity are needed. This communication effort may be combined with the distribution of a ferret "wanted" poster as a means of soliciting ferret sightings from the public and rigorously evaluating the report to determine if further verification is warranted. This is a cost effective method of determining the presence of any remnant ferret population that may still survive.

Finally, the draft recovery plan outlines, after careful evaluation, the steps necessary for a full reintroduction program to proceed. Ferret reintroduction is not expected to occur any time soon. There are serious biological limitations (low prairie dog numbers) that must be addressed first. Socio-political difficulties are anticipated but cooperation with the major landowners, who are primarily federal and provincial governments, is expected to be largely favourable.

Costs of the program for the first five years are limited to supporting monitoring and enhancement of prairie dog populations, public awareness campaign, and developing a ferret sighting report. The major exception here is the establishment and operation of the ferret breeding facility in 1992 at the Metro Toronto Zoo. If reintroduction does eventually proceed, associated costs are expected to rise due to the increased level of activity.

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5. SUMMATION

TO OUR YOUTH AND FUTURE GENERATIONS

Art Allen

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THE ESSENTIAL HABITAT

Habitat is shelter, food, air, water, all those things that support life for every species, including humans. Every living thing is totally dependent on the largesse supplied by mother earth. Our generation has failed, and although we're trying, you and your children may have to fight for your life.

You must look not only at habitat but the very system that governs society throughout the world. There are major road blocks which must be overcome to meet the challenge that our generatiou will leave you. Neither our bias nor remaining time, will allow us to give you the clean earth you should have. "I found the enemy, and he is us."

In 1987 at London, on the occasion of the launch of "Our Common Future" Chairman Gro Harlem Brundtland made a presentation and comments to, and about, young people. "Our common future will require new energy and openness, fresh insights, and an ability to look beyond the narrow bonds of national frontiers and separate scientific disciplines." You have those attributes.

"You are young and fresh, at the beginning of your careers. Your vision is not restricted hy narrow boundaries, lack of foresight, or greed. You will have the time, and action is essential. You are in far greater danger than we, if we fail to change the practices that have caused the problems. Do not take anything we say or recommend as gospel. Honesty has not had priority in our hoard rooms, parliaments, legislatures, city halls, financial circles, or even between ourselves. For far too long, short term gain, without thought of the consequences has been our policy. Be suspicious, investigate, and criticize. We need your input, not as subordinates but as equals!"

It is my helief that the human race may be an endangered species. Yet not one of our generation will live to be affected! There are things that must be, and will be said to assist you to perhaps obtain a better understanding of the task you face to provide a better life for yourselves and your children.

These are your challenges!

Free enterprise is the most effective method of distribution. There is no such thing, but our imitation is more efficient that others. Many changes and controls are required, hopefully by negotiation and cooperation by industry, government, and the general public.

Money was created as a catalyst to improve deficiencies of the barter system. It evolved to the point where, many generations ago, Baron Rothschild commented that whoever controlled the money, controlled the nation, regardless of which government was in power. This evolution continues, and unless action is taken, it will be the multi-nationals, governed by the very few, who will control the world, regardless of governments.

The patent system was initially developed to protect the rights of those who had developed or invented a product which was marketable. It is a reasonable idea, providing the financial hooks are open and there are limits on profits. Evolution has created monopolies and oligopolies who control the most valuable patents in the world! The surrender of our federal government to the pharmaceutical barons, is an example of tremendous power. The research that Trade Minister Wilson extols will cost the citizens of Canada billions of dollars.

Recessions for the rich, and some not so rich, are a pause and opportunity for increasing wealth, at fire sale prices. Costs are loaded on the unemployed, small investors, small business, and the general public. Massive debt accumulated by irresponsible governments, exacerbates the problem.

Politics in this country, we do not have true democracy, but a four year dictatorship. Governments do not own any money. They are trustees for the money they have taken from you! The most blatant example of greed and irresponsibility is the pension plan that our Members of Parliament have given themselves. This has filtered down into provincial and municipal areas. It seems that the public trough is infinite. In major issues, the public must be able to control or defeat government, regardless of the date. In our country,

and that of our southern neighbour, government, "By the people and for the people" is a farce. Changes will not be made by our politicians, unless it is forced during an election. This is one of the toughest challenges you will face!

Growth - The earth's resources are finite. Every item that any species on this earth uses or consumes is either renewable or irreplaceable. Our economists insist that without growth, there is stagnation. Growth really means exploitation of resources, or the concentration on one at the expense of others. Our knowledge of the millions of items which form the earth's resources is infinitesimal! Our ego approaches infinity! What are the costs of our demand for growth? Let's give each economist a rubber sphere representing the earth, pumped up to the critical stage. Each year they would be required to increase the pressure by the percentage by which our economy should grow. Each should be given a bundle of money to clean up the mess when the blow up comes. Money will be worth nothing, for the human race may not exist.

Elimination of poverty - This is one of the most important recommendations in "Our Common Future." A large portion of the population on earth are destroying the environment just to survive. Yet millions die each year from starvation. A solution here will have a major impact on the developed countries, and a decline in the quality of our life. Our generation is not ready, even to eliminate the poverty in our own country. Co-operation, rather than confrontation is the only way to even start to alleviate this disgrace.

I once said that if you brought together a group of ten people to solve a problem, there would be ten solutions. There were twenty-two members from every part of the world in the Commission which unanimously approved "Our Common Future." They and I, believe that human will and cooperation can solve the problems facing this earth.

A problem can not be solved unless you strip away all the factors which obstruct knowledge of the real problem. Every statement I have made is true. Solutions are not difficult to identify, but tremendous power and effort will endeavour to maintain the status quo. However, the most powerful factor on earth, next to nature, is an educated and aroused public.

Power to be effective, must be used wisely and for the benefit of the many. I expect to be around for quite a number of years, and am looking forward to seeing you, supporting you, and hopefully will see the progress you will make to meet the goals which are so important.

Many years from now, I hope you can say, "We have searched for the enemy, and he has become a friend."

GRACE THAT WAS GIVEN AT THE BANQUET

Jennifer Shay

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It was land and water

that brought life into being,

and that sustains and

renews life.

May we respect and

conserve land and water,

and give thanks for

the food we are about to receive.

THE FUTURE OF PRAIRIE CONSERVATION

Ian Milliken

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It is indeed an honor and challenge for me to address you from the perspective of an active mixed farmer with a wildlife background.

The future of prairie conservation is so closely linked to agriculture it can be summed in two words, Land Ethics. As early as 1949, Aldo Leopold (1991) said, and I quote, "I have no illusion about the speed and accuracy with which an ecological conscience can become functional. It has required 19 centuries to define decent man-to-man conduct and the process is only half done; it may take as long to evolve a code of decency for man-to-land conduct."

In the last 40-some years since 1949, prairie farmers have by-and-large gradually divorced themselves from any semblance of a code of decency related to land or water and its native flora and fauna. However, farmers are not ultimately to blame for that loss of ethics and the resulting change in the prairie landscape. On Friday, Crawford Jenkins mentioned how the productivity of our farmers has increased from where one farmer produced enough for one family now produces for thirty. In the years following the dirty '30s and the world wars, farmers were encouraged by government quota delivery systems to put more land under the plow and produce more grain. As urban aspirations and technology changed so did those of the rural community. "So-called experts" said that farmers had to expand to survive; bigger was better. Modern technology produced tractors, cultivators, combines that were bigger, better, and far more expensive. The circle turned as the system cried for more and more efficient production. The quota system and large machinery made it more economical to farm through rather than around wetlands, bluffs, and idle prairie sites. And so the farmer's tie to a land ethic was broken by a system fuelled by government policies and society's demands that they become more efficient or perish. But, I haven't told you anything that most of you don't already know.

What can we do to reverse this trend which continues today and ultimately therein lies the future of prairie conservation. In the immediate future, for at least the next 15 to 20 years, the farmer will have to be reimbursed. Just as we encouraged and rewarded him to destroy his land ethic, we will have to pay to regain it. And, as you know, there are now some programs and personnel in place promoting and working to that end. In Manitoba, the Critical Wildlife Habitat has done an excellent job to date with the funds available. The North American Waterfowl Management Plan, although focused primarily on waterfowl, has the potential to impact a diversity of flora and fauna, and it is a classic example how various organizations, wildlife, and agriculture can work together toward a common end.

Over the long-term, governments and society must send clear and non-conflictive signals to the rural community that small family farms will he supported and maintained and that the past system of mono-culture wheat production must be diversified. Clearly some of those signals are there. Sustainable agriculture is with us, Farming For Tomorrow groups are coming to the forefront, Prairie Farm Rehabilitation Administration has the Permanent Cover Program, and naturalists and environmentalists have a higher profile in our society.

Yes, there is a future, but we have only seen the light at the end of the tunnel. The quota delivery system is still in place, and we now have the Gross Revenue Insurance Plan (GRIP). If the family farm and rural community are to survive under diversified sustainable agriculture systems, GRIP must be terminated and replaced by a more ecologically-friendly subsidization program.

In a short 50 years, we have destroyed much of what took centuries to build. We do not have that much time to rebuild it. Agriculture cannot survive with a system that considers its resources unlimited. The current scenario for agriculture and prairie conservation is at a turning point. From what I have heard at this workshop, it is very clear there is a strong commitment to make that change. Where there is a will, there is always a way.

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SUMMARY

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The workshop and these proceedings are a success because of the number and diversity of people present who are concerned about the prairies, its wildlife and its people; the prairie landscape. The almost 100 papers have come from the efforts of the steering committee, the session chairs, the speakers, and particularly the authors who took the time to document their words.

During the workshop, one-third of the presentations were about agricultural perspectives of wildlife issues, our target subject. Of the remaining two-thirds many speakers incorporated agricultural concerns in their wildlife talks. As biologists we are becoming more aware of the effect of non-biological topics such as economics and ethics on the wildlife and habitats that we study. Also encouraging at this workshop was the involvement of landowners who made up one-third of the speakers. It is this continued dialogue that will help us to find new solutions to create a healthy prairie economy and ecology.

Most working sessions had considerable discussion after the presentation of papers. Some session chairmen have provided summaries of this discussion in these proceedings and some speakers have incorporated the comments into their papers. Here are the notes from two sessions to provide examples of the outcome of the working sessions.

Loney Dickson chaired the session on the concerns for grassland wildlife. The session concluded that researchers and biologists need to communicate more often with landowners, both ranchers and farmers. Biologists not only need to pass on the results of their studies but also talk to landowners while the studies are underway. This community level contact will increase the understanding both ways. Biologists and landowners are more likely to understand each other's perspective, consequently the conclusions of their studies are more likely to be implemented. The session encouraged more research on Crown lands to identify the types of grazing regimes needed for various wildlife communities and for grazing animals. Grazing should encourage the creation of "natural" conditions to benefit livestock and wildlife. Finally, outdoor recreation needs to be integrated with grazing and wildlife to provide greater diversity in ranch income. Thus the concerns for grassland wildlife need to be combined with human activities and considered as parts of a grassland landscape.

From the Multi-use Water Management session John Towle writes, "In today's society, we are becoming more aware of the need to plan, construct, and manage projects in an integrated and coordinated approach. The issues of land and water are becoming more complex and new approaches are needed to ensure development is in harmony with our environment. In this session we looked at case studies where people working together have developed or are planning to develop multi-use water management projects with attempt to fulfil the following goals of Manitoba's land and water strategy component of sustainable development: to sustain resources, enhance productivity, and improve environmental quality including human health; to improve and diversify income and job opportunities; to manage resource and related activities so as to preserve development options for future generations; and to protect natural systems, maintain the genetic diversity of species, and preserve the resilience and productivity of the ecological system." Clearly water management is another component of the prairie landscape.

During the final plenary session three speakers—Monte Hummel, Robert Sopuck, and Ian Milliken—told us of their vision for prairie Canada, the prairie landscape.

Monte Hummel, President of World Wildlife Fund (WWF) Canada, reminded the audience of the balance between preservation and sustained use (conservation) that is promoted in the Prairie Conservation Action Plan (PCAP). Many speakers pointed out the negative environmental impact of current agricultural subsidies. Monte pointed out that the new GATT (General Agreement on Tariffs and Trade) agreements may change the foundation of agricultural subsidies. Under the proposed revisions to GATT, production subsidies will not be allowed. However, subsidies to protect the environment or to diversify the economy will be acceptable. Thus a landowner could be paid to maintain permanent cover for soil and wildlife conservation

rather than for ploughing marginal lands. Likewise the landowner could be paid to diversify his income by building a guest house for farm holidays, thus promoting local tourism. He challenged us to implement the PCAP and to be prepared to measure our progress in 1995 at the next Prairie Conservation Workshop. At that time we need to update the PCAP based on the psychology of its success. He said that WWF is prepared to help but does not want to lead the charge.

Bob Sopuck, a landowner and advisor to Manitoba Premier Filman, spoke of his broad involvement in the prairies as a hay farmer, tour guide, outfitter, fisheries biologist, and civil servant. As a hunter he wondered if he was out of place among conservationists but there were more hunters in the audience than he knew. Nevertheless this concern gave rise to his notable quote, "You can't understand the environment unless you eat part of it." As the Premier's environment spin doctor he warned us that, "for every problem there is a solution that is quick, short, and wrong." As we seek solutions to environmental problems we must remember that the source of our pay cheque colors our thinking. What we need to achieve are millions of decentralized decisions on behalf of the environment. While striving to achieve this goal with landowners we must realize that they are attached to their land, their house and home.

Ian Milliken, a fourth generation farmer from Reston, Manitoba, has provided his own text which precedes this paper. In it he argues that wildlife has to pay its way. He believes the new GATT agreement has great potential to achieve this goal.

So what are the bottom lines from the workshop. Here are two that struck me. Ninety percent of the prairies is privately owned, and billions of dollars are spent each year on agricultural subsidies to these landowners. From the summary discussion we heard that we need to understand people, their lifestyle, and the origin of their ideas. In the introductory session we were cautioned that wildlife has to pay its way. The solution to the long-term conservation of prairie wildlife may lie in the new GATT agreement and the opportunity to channel billions of dollars into "amber" or environmental subsidies.

When we think of the fourth workshop, we need to define a theme and objective to build on the first three. Timothy Myres suggests that we review how the prairie soils and grasses replenish and stabilize the prairies, how nutrients are recycled into the soils, the optimal conditions for microbial activity, and the effects of various land use and inputs (fertilizers and pesticides). Two groups of organisms that have yet to be viewed adequately at the workshops are insects and fishes.

Although we have much to learn about the ecological interactions of the natural prairie ecosystems we need to find a new perspective for solving biological problems. Likewise landowners have many economic and agricultural problems to solve. We need to consider the prairies an integrated landscape of wildlife, its habitat needs, landowners and their desire to live on the land. The next workshop must continue this dialogue to work toward a sustainable prairie landscape.

Finally, I wish to thank the steering committee for all their hard work over two years to plan this workshop. Their efforts are rewarded by the large attendance of 350 registered participants who heard 132 presentations in 56 sessions. In the 3-day workshop there were enough talks to fill 11.5 days of presentations.

Until the next workshop I urge you to work toward conservation as though your life depends on it, because it does!

Proceedings of the Third Prairie Conservation and Endangered Species Workshop

Holroyd Dickson Regnier Smith

NATURAL HISTORY OCCASIONAL PAPER TITLES

No. 1	Alberta Birds 1961-1970. 1976. T.S. Sadler and M.T. Myres. 314 pp. (out of print)
No. 2	Mammals of the Edmonton Area. 1979. Hugh C. Smith. 34 pp. (out of print)
No. 3	A Bibliography of Alberta Ornithology. 1981. Martin K. McNicholl, Philip H.R. Stepney, Peter C. Boxall, and David E. Spalding. 380pp. (out of print)
No. 4	Plants and the Blackfoot. 1982. Alex Johnston. 106 pp.
No. 5	Rare Vascular Plants of Alberta. 1984. John G. Packer and Cheryl E. Bradley. 112pp.
No. 6	A Checklist of the Mammals of Alberta. 1985. Hugh C. Smith. 11 pp. (out of print)
No. 7	Mammals of Southeastern Alberta. 1986. Hugh C. Smith. 59 pp. (out of print)
No. 8	A Bibliography of Alberta Mammalogy. 1987. David M. Ealey. 400 pp.
No. 9	Proceedings of the Workshop on Endangered Species in the Prairie Provinces. 1987. Geoffrey L. Holroyd, W. Bruce McGillivray, Philip H.R. Stepney, David M. Ealey, Garry C. Trottier, and Kevin E. Eberhart (eds.). 367 pp.
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No. 12	Natural History of the Andrew Lake Region, Northeastern Alberta. 1990. W. Bruce McGillivray and Ross I. Hastings (eds.). 97 pp.
No. 13	Alberta Birds, 1971-1980. Volume 1. Non-Passerines. 1991. Harold W. Pinel, Wayne W. Smith, and Cleve R. Wershler. 243 pp.
No. 14	Bibliography of the Family Catostomidae (Cypriniformes). 1991. John Clay Bruner. 224 pp.
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No. 19	Proceedings of the Third Prairie Conservation and Endangered Species Workshop. 1993. Geoffrey L. Holroyd, H. Loney Dickson, Mona Regnier, and Hugh C. Smith (eds.). 384 pp.
No. 20	Alberta Birds, 1971-1980. Volume 2. Passerines. 1993. Harold W. Pinel, Wayne W. Smith, aud Cleve R. Wershler. In press.