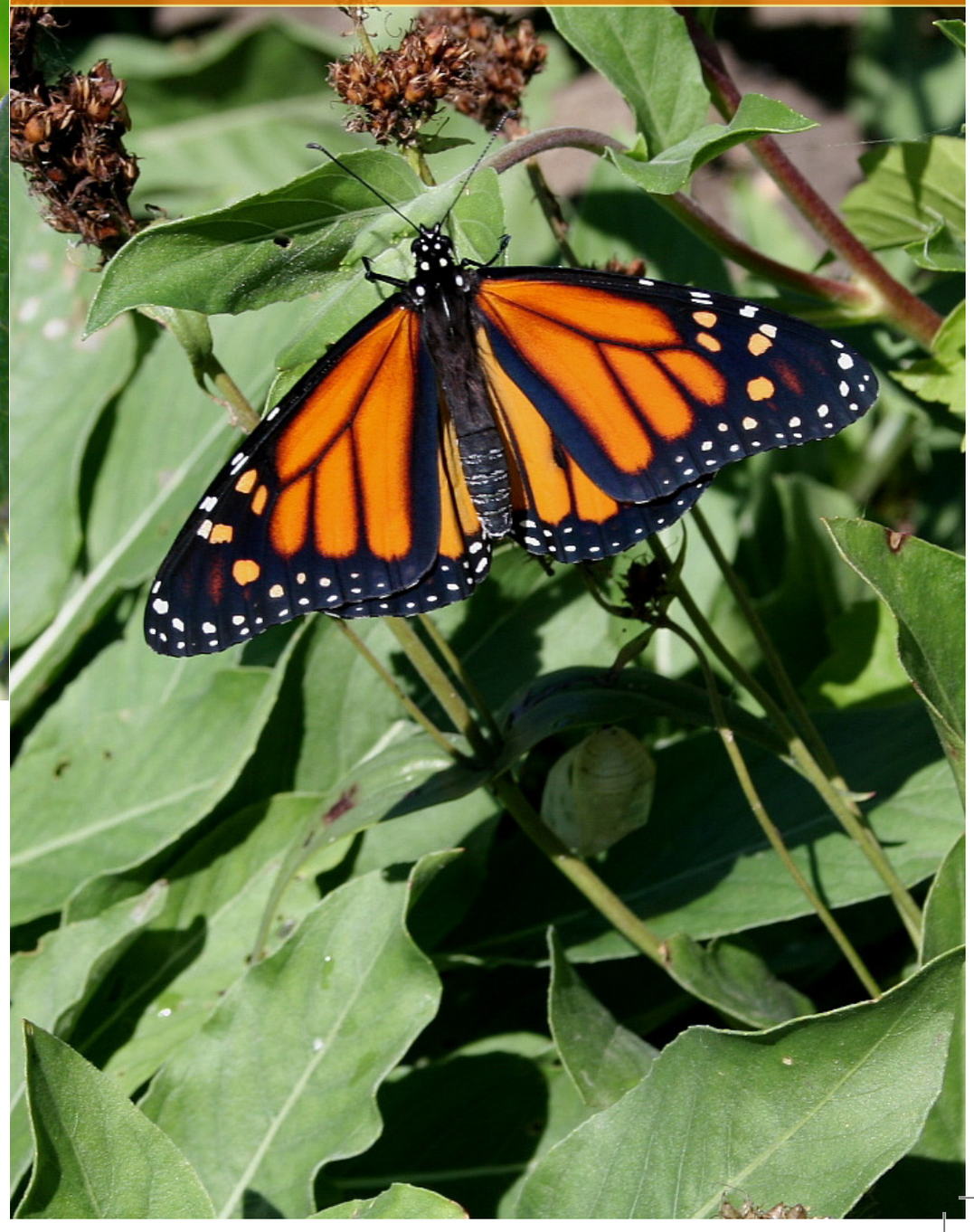
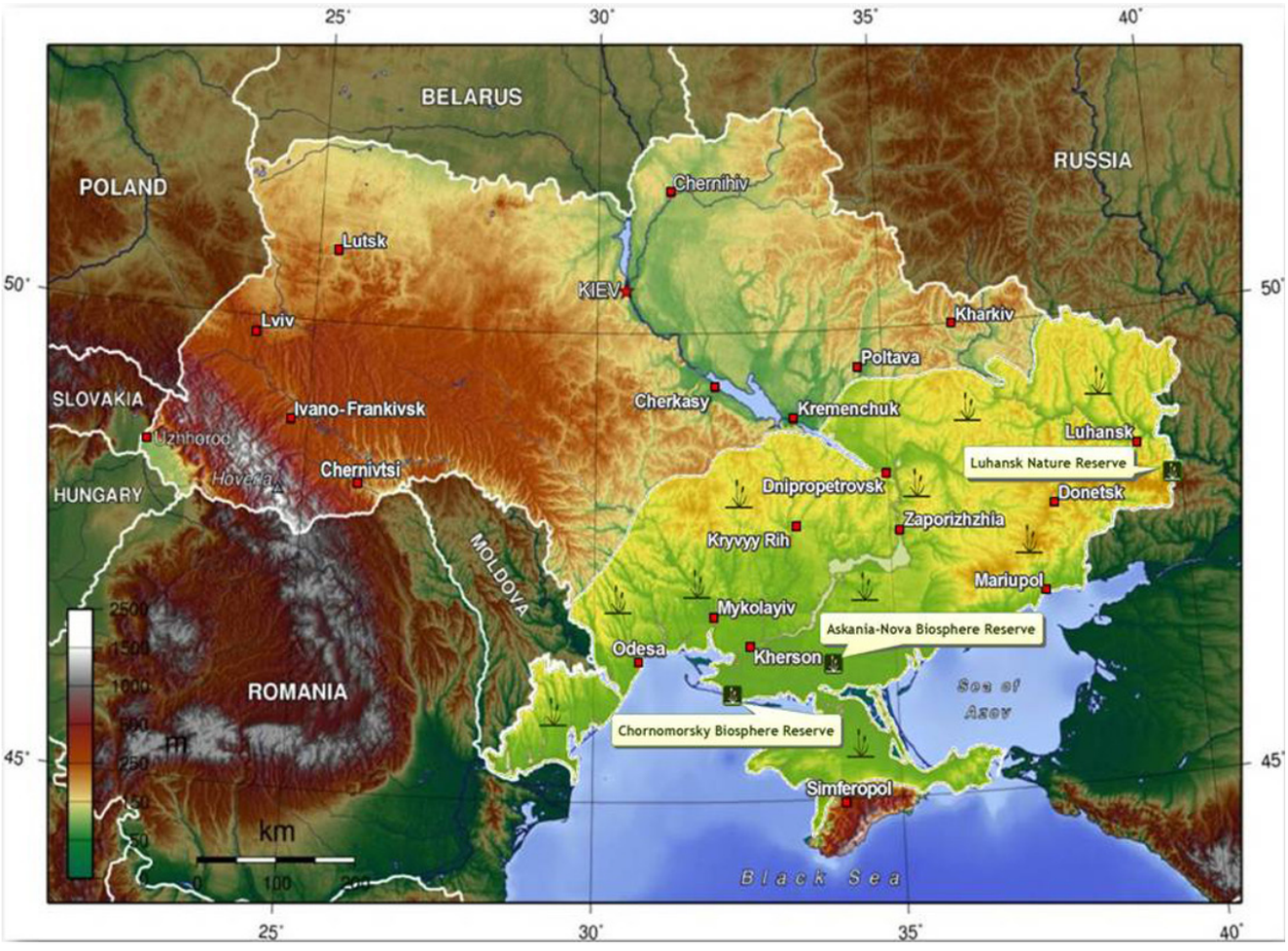
BLUE JAY

Volume 70 Number 2 June 2012



Publication Mail Agreement #40063014
Return Undeliverable Canadian Addresses to:
Administration Centre Printing Services
111-2001 Cornwall Street
Regina, SK S4P 3X9
Email: adminprint@sasktel.net


25°
30°
35°
40°
50°
45°
BELARUS
RUSSIA
POLAND
SLOVAKIA
HUNGARY
ROMANIA
MOLDOVA
Chernihiv
Lutsk
KIEV
Lviv
Kharkiv
Poltava
Cherkasy
Kremenchuk
Ivano-Frankivsk
Uzhhorod
Chernivtsi
Luhansk
Luhansk Nature Reserve
Dnipropetrovsk
Donetsk
Zaporizhzhia
Kryvyy Rih
Mariupol
Mykolayiv
Askania-Nova Biosphere Reserve
Odesa
Kherson
Sea of Azov
Chornomorsky Biosphere Reserve
Simferopol
Black Sea
2500
1500
1000
500
250
150
50
m
km
0
100

Blue Jay

Vol. 70 No. 2 June 2012 69 - 132

Front Cover: New adult Monarch butterfly and empty chrysalis
Lois Vanthuyne, EC-CWS Last Mountain Lake NWA

Back Cover: Monarch Caterpillar
Lois Vanthuyne, EC-CWS Last Mountain Lake NWA

Inside Front Cover: Weasel
Leland Greenfield

Inside Back Cover: Map of the Ukrainian steppe (yellow shaded area) and locations of the study sites.
Vladimir Kricsfalusy

Editors' Message

We would like to invite you, the readers of Blue Jay, to send in photos, comments, and nature notes. Please feel free to share any interesting sightings, odd or unusual behaviours, or new species records for your area. Blue Jay is the journal for Nature Saskatchewan, and we want to reflect what you are observing. Don't worry about your notes being perfect, or your photos well-composed, because that is what the editors are here to help with. We are quite pleased to assist in making written observations clear and to the point. We also can edit photos to some extent, which can improve them significantly, as long as they are large enough in size.

If nothing else, we would be very happy to hear of interesting natural history occurrences in the prairie provinces that would be worth recording. Please drop us a note if you are aware of any significant occurrences. **bluejay@naturesask.ca**

As an example, this summer many people noted a large number of monarch butterflies in Saskatchewan and Alberta. We began inquiring, and found a number of great images from a variety of photographers. Upon our request a retired biologist, Phillip S. Taylor, agreed to compile the available information about monarch butterflies and the reasons behind their influx to the Canadian prairies in the summer of 2012. We are quite pleased with the result (An Unparalleled Influx of Monarchs, page 122), and hope you are, too.

Kerry and Lowell

THIS ORGANIZATION RECEIVES FUNDING FROM:
Saskatchewan LOTTERIES LOTTERY TICKET CENTRE

BIRDS

MOBBING OF GREAT GRAY OWLS AT THE NEST

SPENCER G. SEALY, *Department of Biological Sciences, University of Manitoba, Winnipeg, MB R3T 2N2*

Introduction

Observations abound of animals approaching predators when they initially encounter them, in what seems at first to be a paradoxical strategy. The animals eventually retreat and return to their territories or rejoin conspecifics nearby; however, in some instances the behaviour escalates and the animals attack the predator, harassing or mobbing it.[1] A small bird, or more often a group of birds, mobbing a Red-tailed Hawk (*Buteo jamaicensis*) or a Great Horned Owl (*Bubo virginianus*) is a common sight, but few people have witnessed, and photographed, mobbing or harassment of Great Gray Owls (*Strix nebulosa*). Herein I describe, with a series of photographs, mobbing of a pair of Great Gray Owls at a nest in the Spruce Siding area of southeastern Manitoba. I also report an additional observation of mobbing at this nest on an earlier visit and two episodes of mobbing at another gray owl nest in Minnesota, all in 1974. These observations, albeit anecdotal and involving only five episodes of this behaviour at two gray owl nests, add to the growing body of observations of the interactions between nesting Great Gray Owls and other species, including potential predators and nest competitors.[2] Counterattacks have been recorded occasionally during episodes of predator mobbing, sometimes with deadly results, revealing that under some circumstances mobbing is dangerous.[3,4] It is, therefore, important to determine the outcomes of these events, whenever possible.

The Nests and Observations

Efforts to observe Great Gray Owl nests near the U.S.-Canadian border, north of Roseau, Minnesota, were prompted by the discovery and an extensive photographic study of a nest by Robert W. Nero, Dalton Muir and Robert R. Taylor, in 1970.[5,6,7] The collapse of this nest later in the season prompted Nero and others to erect two artificial nests nearby, one in 1970 that was visited by a gray owl in late winter 1971 but the nest was not occupied that year, or in 1972 or 1973. The second artificial nest was built in winter 1973 and was occupied weeks later by a pair of hawks, possibly Red-tailed Hawks and by a pair of Red-tailed Hawks in 1974.[7] The first artificial nest was finally used by gray owls in 1974 and two eggs were laid (Figure 1). Two observations of mobbing were made at this nest on 25 May.

Figure 1. Great Gray Owl clutch in artificial nest, north of Roseau, MN, 25 May 1974.

During a brief visit on 25 May 1974, the female owl, which was perched

conspicuously several meters to one side of the nest, was mobbed for nearly six minutes simultaneously by two adult Gray Jays (*Perisoreus canadensis*) before they abruptly left the area. This was followed less than one minute later by a single pass by a Red-tailed Hawk, uttering the familiar hoarse scream, *kee-eee-arrr.*[8] In each case, the mobbing birds retreated and were not seen during the remaining few minutes that I was at the nest site. The male owl was not seen.

The discovery of the nest near Spruce Siding, in 1973, by Robert W. Nero and Robert R. Taylor, was described eloquently a few years later in Nero's book *The Great Gray Owl: phantom of the northern forest.*[9] The initial search for the nest was prompted by a sighting of a Great Gray Owl crossing a road carrying a vole in its bill, a telltale sign that a male owl was on its way to a nest with food to be passed to an incubating or brooding female. The nest was in a deformed tamarack surrounded by dense cover in a spruce-tamarack bog (Figure 2), and contained a single owlet. This nest was used again in 1974, quite possibly by one or both owls that used the nest the previous year.[2] I visited the nest four times in 1974, on 17 May and 8 June, when the observations of mobbing behavior were made, and with Nero on a date in late May and on 2 June. The nest contained three eggs on my first visit, 17 May, but by late May Nero and I recorded two newly hatched young and one unhatched egg. By 2 June a dead one-day-old chick lay under the nest and the two slightly older chicks remained in the nest. The nest contained two owlets when I visited it again on 8 June but when Nero visited the site again several days later in the month, the skimpy nest had collapsed and neither the adults nor the owlets were seen again.[9] The nest was "rebuilt" by Nero on the same branch and reinforced by a wire basket.[10]

On 17 May 1974, as I started to climb down from the nest, the female owl, which

Figure 2. Great Gray Owl nest in a spruce-tamarack bog near Spruce Siding, MB, 8 June 1974.

was perched on a dead branch about 8 m high and just off to the side of the nest was attacked seven times by a screaming Broad-winged Hawk (*B. platypterus*), each pass missing the owl by less than 1 m. The female followed the hawk with its eyes during each pass, slightly ruffled her plumage in a defensive attitude, and shifted her position on the branch a couple of times until the hawk left abruptly. The male owl was neither seen nor heard during this episode. On 8 June, at the same nest, I observed, initially, a male gray owl, which was perched about 30 m from its nest, being watched from above by an adult Gray Jay. As I approached the male owl on my way to the nest, the jay flew in and perched about 1.5 m above the male owl and remained there for at least three minutes without attacking the owl. The owl looked up from its perch at the jay continuously during this time but neither the jay nor the owl moved nor uttered vocalizations that I could hear (Figure 3A and 3B). When I eventually approached the nest site, the female owl flushed and perched at about the same height on the same branch from which she was mobbed by the Broad-winged Hawk on my previous visit, and peered fixedly at me. She then moved to a branch near the top of a dead spruce above the nest and, minutes later, the female abruptly turned toward a Red-tailed Hawk as it attacked her (had she heard it coming?), almost forcing her to lose her footing each of the five times the hawk attacked the owl (Figure 4A - C). The owl changed perches but remained similarly conspicuous at the top of a live spruce above the nest. The hawk retreated and was not seen again; however, within a few minutes an adult Gray Jay began to mob the owl (Figure 4D - F). As far as I could determine, neither the jay(s) nor the hawk struck either of the owls, but they came close, and the passes by the hawk elicited defensive responses by the female owl (Figure 4).

Figure 3. Male Great Gray Owl peering up at a Gray Jay perched motionless about 1.5 m above it, near Spruce Siding, Manitoba, 8 June 1974.

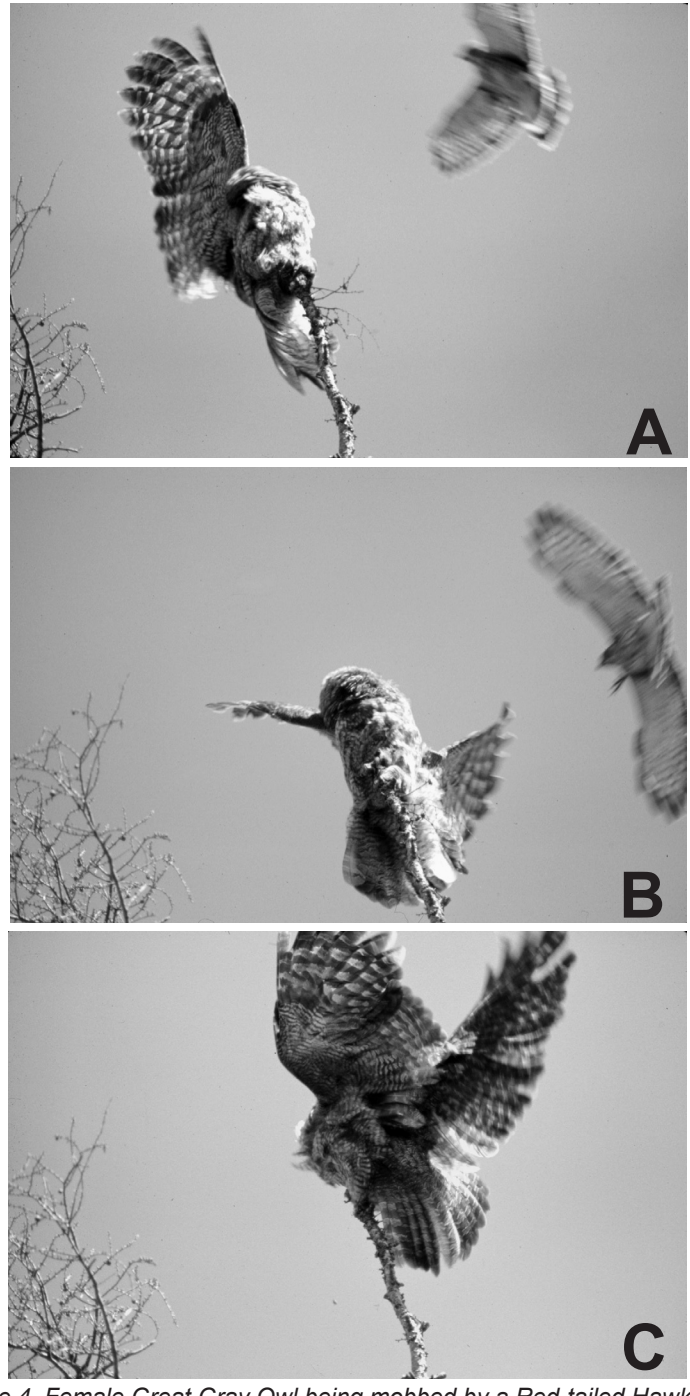
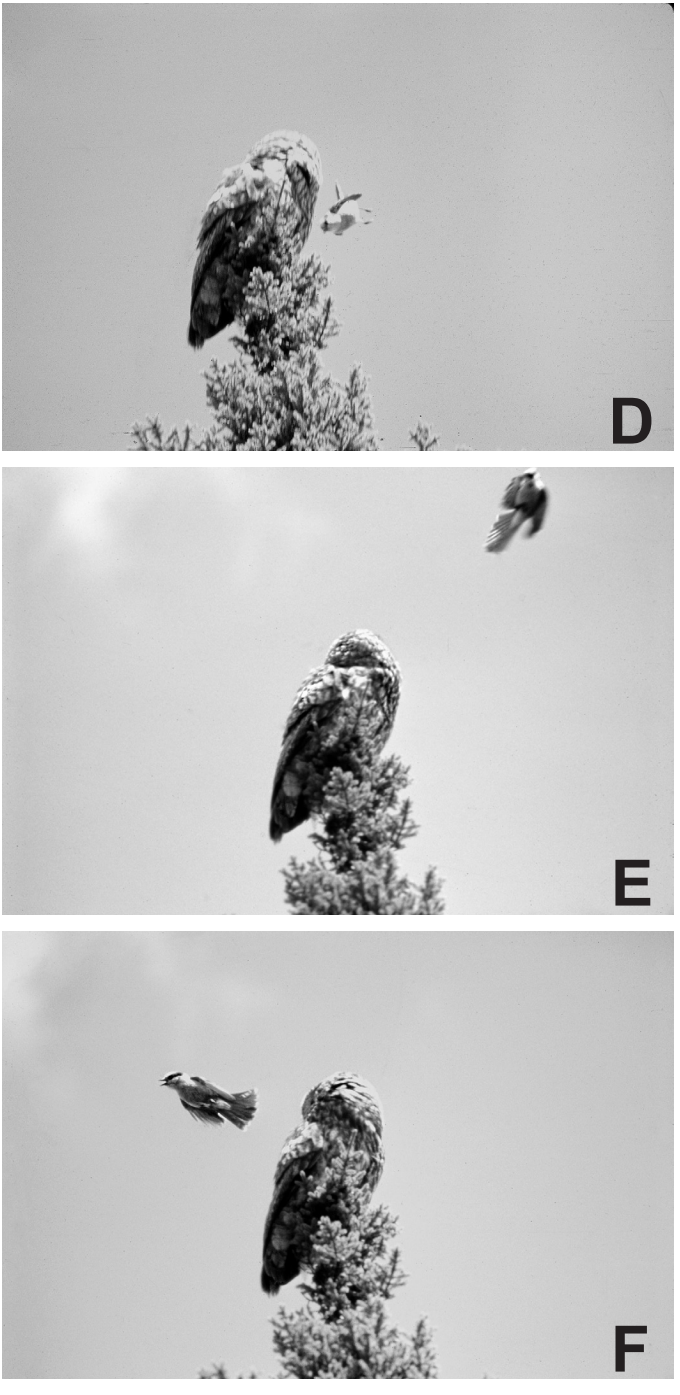


Figure 4. Female Great Gray Owl being mobbed by a Red-tailed Hawk (A-C) and a Gray Jay (D-F), near Spruce Siding, Manitoba, 8 June 1974


D
E
F

The owl seemed to follow the jay with its eyes as it passed by but it did not shift its position, as it had when the hawk attacked. Neither the male nor the female owl motioned toward or counter-attacked the hawk or the jay, and they did not retreat to denser cover. The male owl was not seen while the female was mobbed and its occasional hoots originating from nearby did not elicit vocal responses from its mate.

Observations by Other Naturalists

Other naturalists have observed Great Gray Owls in the Prairie Provinces infrequently being attacked or investigated by apparently curious birds. Oeming observed a Great Gray Owl in Alberta reacting to a single pass by a Red-tailed Hawk by "… immediately assum[ing] a defensive attitude, hunching the shoulders and fluffing out the feathers …. She made no attempt to fly at the hawk, which in turn made no further assaults."[11] One of the first naturalists to record observations of the behaviour of the Great Gray Owl in Saskatchewan, near Choiceland, was Law[12], who stated:

> … [o]n several occasions I have seen chickadees and juncos in the same tree only a few feet away from the [Great Gray] owl but making no commotion. They merely seemed curious about the owl. The owl, for its part, didn't pay the slightest attention to these small birds. I have also seen Blue Jays [*Cyanocitta cristatus*] in the same tree which showed no signs of fear of the owl, and the owl made no move to attack them.
>
> … these owls have few enemies. I have seen a Goshawk [*Accipiter gentilis*] on several occasions making dives at one, but the owl merely ruffled its feathers and ducked its head, until the Goshawk moved on.

Despite observing many Great Gray Owls during a large influx of individuals into Manitoba during the winter and spring of 1968-69, Nero infrequently recorded interactions between Great Gray Owls and other species.[13] He noted:

> Our observations of contacts between Great Gray Owls and other species of birds are limited but similar to reports by others …, there being nothing to indicate that birds regard this species as an enemy. On a few occasions a Common Raven [*Corvus corax*] made a casual pass at a perched owl and once a Gray Jay flew in briefly. The owls were otherwise ignored though there were lots of opportunities for Black-capped [*Poecile attricapilla*] and Boreal [*P. hudsonicus*] chickadees, Gray and Blue jays and other species, to come in contact with them.

Even newly fledged Great Gray Owls (Figure 5) are not immune to attacks by other birds. Nero described (p. 122) an incident near the Roseau nest in 1970 "… one youngster being harassed by several birds, a mob scene involving a Northern Flicker [*Colaptes auratus*], Blue Jay, Gray Jay, and several Black-capped Chickadees. The owl flew off clumsily when [Nero] approached, flapping away with legs dangling, and made an awkward landing on a branch." [9] Nero's observation of the fledgling owl being mobbed by several species attacking or investigating the owl simultaneously, which is more typical of what is usually considered as mobbing. None of the attacks on the adult Great Gray Owls that I described attracted other individuals, of the same or other species, to the scene.

Discussion

The behaviour of the hawks and jays I describe suggests that these species were nesting in the area or, in the

Figure 5. One of two Great Gray Owls fledged from a nest near Lac du Bonnet, Manitoba, July 1974.

case of the earlier-nesting Gray Jays, possibly were attending fledged young; however, nesting by either species was not confirmed near the Spruce Siding nest. The Red-tailed Hawk that attacked the female owl near the nest in Minnesota was likely one of a pair that was nesting nearby, but this could not be confirmed. Individuals are known to mob putative predators outside the breeding season but the number of birds involved and the duration of mobbing generally wanes over the weeks following the breeding season.[14] The Gray Jays likely perceived the male and female Great Gray Owls as threats, despite the fact that Great Gray Owls rarely take birds, although the Gray Jay is among the few species of birds that have been recorded in the Great Gray Owl's diet.[2] The jays may have mobbed the Great Gray Owl simply because they recognized it as a large owl, "... or [as] a stimulus resembling [it]" [14] because the potentially more dangerous Great Horned Owl also occurred in the same general area. The jay was the first and apparently only bird to react to the presence of the male owl, which, unlike the female owl, was perched under a dense canopy (Figure 2), where it may have been less accessible to aerial attacks from above. The (other?) jay may have reacted to the attacks on the female owl by the Red-tailed Hawk and followed suit, mobbing the owl only after the hawk left the area. This explanation seems unlikely, however, because the jays were the first to mob the owl at the Roseau nest, followed by the Red-tailed Hawk.

The motive for mobbing the Great Gray Owl by the apparently more powerful Red-tailed Hawk, and possibly Broad-winged Hawk, is not readily evident, although the Red-tailed Hawk has been recorded depredating young Great Gray Owls.[15] Great Gray Owls use broken-topped snags and old nests built by other species in previous years, primarily by hawks and, occasionally use mistle-toe brooms; hence, there may be an unappreciated competition for these nests, as hawks will use old nests again in subsequent years. Observations are numerous of Broad-winged and Red-tailed hawks, and other species, attacking other species of hawk, within and outside of the breeding season, and in some cases apparently pirating their food or killing them, and also counter-attacking.[16,17,18,19,20,21,22]

The behavioural interactions that I described may have been somewhat artificial because the jays and hawks may have responded initially to my presence near and at the owls' nests, and then focused their attacks on the female owls when they perched conspicuously above and beside their nests. My observations, however, suggest that the hawks' attention was directed solely toward the owls because they did not appear and react to me as I walked through the bog toward the owls' nests, as I would

have expected if they were responding to my presence. Instead, the hawks immediately directed their attention toward the owls, almost as soon as they perched conspicuously after I arrived at the nest sites. None of the hawks lingered after they stopped mobbing the owl, even though I remained at the nest sites for several minutes. Martin McNicholl (pers. comm.) suggested that if the hawks and/or jays were nesting near the owls, they may have habituated to the owls' proximity and did not attack them if they remained out of sight most of the time, then they attacked when the owls suddenly became conspicuous, as in their response to me. He documented habituation of aggressive responses by nesting terns (*Sterna* spp.*)* toward potential avian predators that nested within or alongside the colonies.[23] Undisturbed Great Gray Owls are fairly inconspicuous around the nest, depending on the density of the habitat and the nest's exposure (Nero 1980); however, male Great Gray Owls also hunt during the day, thus attracting attention, especially when the owls are carrying prey to the nest; this may provide opportunities for food piracy. Long-term video-monitoring of Great Gray Owl nests, may provide a more unbiased description of the frequency of interactions between the owls and other species encountered at their nests.

Acknowledgements

I am indebted to Bob Nero and Herbert W.R. Copland for the pleasure of accompanying them on their far-reaching travels throughout southeastern Manitoba and northern Minnesota in search of Great Gray Owls and their nests. One does not soon forget the sight of a Great Gray Owl perched atop a pole or on the tip of a spindly tamarack at the forest's edge as it scans a field listening for telltale signs of a vole under the snow, seemingly oblivious to the humans watching it from a nearby road. I thank Martin K. McNicholl, R. Wayne Nelson and Robert W. Nero for providing thought-provoking comments on the manuscript and suggesting additional references.

1. Dugatin LA (2004) Principles of Animal Behavior. W.W. Norton, New York, NY.

2. Bull EL, Duncan JR (1993) Great Gray Owl (*Strix nebulosa*), no. 41 in The Birds of North America (Poole A, Gill, F, editors). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

3. Hennessy DF (1986) On the deadly risk of predator harassment. *Ethology* 72:72-74.

4. Sordahl TA (1990) The risks of avian mobbing and distraction display: an anecdotal review. *Wilson Bulletin* 102:349-352.

5. Nero RW (1970) Great Gray Owls nesting near Roseau. *Loon* 42:88-93.

6. Muir D (1972) At a nest of the Great Gray Owl. *Nature Canada* 1(2):20-22.

7. Nero RW, Sealy SG, Copland HWR (1974) Gray Gray Owls occupy artificial nest. *Loon* 46:161-165.

8. Preston CR, Beane RD (1993) Red-tailed Hawk *(Buteo jamaicensis*), no. 52 in The Birds of North America (Poole A, Gill, F, editors). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

9. Nero RW (1980) The Great Gray Owl: phantom of the northern forest. Smithsonian Institution Press, Washington, D.C.

10. Nero RW (1982) Building nests for Great Gray Owls. *Sialia* 4:43-48.

11. Oeming AF (1955) A preliminary study of the Great Gray Owl (*Scotiaptix nebulosa nebulosa*) (Forster) in Alberta with observations on some other species of owls. M.Sc. thesis, University of Alberta, Edmonton, AB.

12. Law C (1960) The Great Gray Owl of the woodlands. *Blue Jay* 18:14-16.

13. Nero RW (1969) The status of the Great Gray Owl in Manitoba, with special reference to the 1968-69 influx. *Blue Jay* 27:191-209.

14. Altmann SA (1956) Avian mobbing behavior and predator recognition. *Condor* 58:241-249.

15. Bull EL, Henjum MG (1990) Ecology of the Great Gray Owl. United States Department of Agriculture, Forest Service, General Technical Report, PNW–GTR–265.

16. Broun M (1947) Golden Eagle captures Red-shouldered Hawk. *Auk* 64:317-318.

17. Collins CT (1962) Red-tailed Hawk attacks Long-eared Owl. *Wilson Bulletin* 74:89.

18. Weigand JP (1967) Ferruginous Hawk attacks Great Horned Owl. *Auk* 84:433.

19. Clark RJ (1971) Red-tailed Hawk attempts piracy of Sparrow Hawk? *Kingbird* 21:10.

20. Todd DM (1980) Golden Eagle killing Buzzard. *British Birds* 73:536-537.

21. Nero RW (1994) Short-tailed shrew apparently cause of mortality of Eastern Screech-Owl. *Blue Jay* 52:176-178.

22. Gibson MJ, Gibson DC, Bardelmeier DG (1998) Prey conquers predator: a case study. *Journal of Wildlife Rehabilitation* 21:19-21.

23. McNicholl MK (1973) Habituation of aggressive response to avian predators by terns. *Auk* 90:902-904.

MAMMALS

WEASELS; NOT ALWAYS PUSHOVER PREY FOR RAPTORS

WILLIAM J. WALLEY, *222 Bossons Ave., Dauphin, Manitoba, R7N OR2*

Known avian predators of weasels (*Mustela sp.*) include: northern goshawk, red-tailed and rough-legged hawks; northern barred, great horned and snowy owls.[1, 2, 3, 4, 5, 6, 7, 8, 9] Banfield excluded mustelids as prey of raptors.[10] On occasion weasel remains link these mustelids to unusual predators such as the discovery at Hamilton Bay, Ontario where a bald eagle (*Haliaeetus leucocephalus*) that had been shot, had a "bleached skull of a weasel hanging firmly fastened by the teeth into the skin of its throat, a gruesome relic of a former desperate struggle" reported by Thomas McIlwraith to A.C. Bent.[1] In 1980 the author discovered the skull of a short-tailed weasel (*Mustela erminea*) in the cast pellet of a short-eared owl (*Asio flammeus*) near Dauphin, Manitoba, the only reported such record for this owl species for the entire holarctic.[11] No

records consulted reported the northern harrier (*Circus cyaneus*) as a predator of weasels but on 30 April, 1995, a large short-tailed weasel was seen running across a snow drift toward a thicket of willows behind the beach ridge at Stony Point on the west shore of Dauphin Lake, the outcome of which was undetermined.

Fearless, the weasel backs up its feisty nature with sharp teeth and claws making a raptor's intent of having a meal of weasel far from a certainty - not to dismiss the fact that the weasel may, on occasion, be the aggressor as noted by Criddle and Criddle.[12] J.K. Terres noted a red-tailed hawk (*Buteo jamaicensis*) being bitten and killed by a weasel that had been carried aloft by the hawk.[2]

In western Manitoba various verbal accounts have been described to the author where weasels have successfully escaped from raptorial birds in flight. Over a hay field just south of Riding Mountain National Park (RMNP) a farmer noted a red-tailed hawk experiencing flight difficulties. Suddenly the hawk plunged to the earth whereupon impact a weasel ran off. The hawk was quickly attended to and was found to have sustained several bites but took wing shortly (D. Juce, Pers. Comm.). One summer in the Birdtail Valley near Birtle, another red-tailed hawk didn't fare as well. Acting unusual above its observer E.C. Walley (Pers. Comm.) it fell to the earth, again with a weasel running away. The bird soon hemorrhaged to death from a laceration of a large blood vessel in its neck.

J.D. Robertson (Pers Comm.) former supervisor of Conservation Officers in northern Manitoba related a sighting made by one of his C.O.s in the 1940s: one winter morning a Snowy Owl was seen in flight in the delta of the Saskatchewan River east of The Pas. Suddenly and to the utter amazement of the officer, the owl began to have difficulty flying and soon fell to the snow-covered ice, whereupon a short-tailed weasel loped off. Examination of the owl showed that a large blood vessel under one of its wings had been severed.

This report describes a weasel-raptor struggle with a different twist. It occurred under overcast skies at 8:30 hours on 26 November, 2005 some 12 km WNW of the City of Dauphin, Manitoba north of RMNP. That morning four of us were proceeding by vehicle along a frozen dirt road adjacent an alfalfa field in farmland/aspen grove habitat when someone yelled: " a hawk with a rabbit's leg!" Looking from the far side of the vehicle I saw a rough-legged hawk (*Lagopus lagopus*) with an ermine (short-tailed weasel) in its talons as it lifted above the field about 20 m S of us. The weasel which had been grasped in the shoulder area, hung limp and appeared to be decapitated although no blood could be seen. Within two or three seconds, the hawk, with wings beating hard, dropped the seemingly dead ermine which fell 1.5 m to the ground. Instantly upon contact with the earth the weasel "sprang to life" and began chasing the hawk leaping upward 50 - 60 cm at it at least twice before the buteo was well out of reach flying 100 m to a bale where it alighted apparently uninjured. The field which was a mosaic of 8 - 10 cm deep snow and mowed alfalfa patches, was immediately and intensively searched, not only for the weasel itself, but for drops of blood that would have indicated injury to it. However neither was found.

It cannot be assumed that the weasel escaped on its own. One early summer morning while driving along a highway, a red-tailed hawk suddenly flushed from the ditch with prey in its talons. As my vehicle came abreast of it the hawk dropped a fairly well grown young American coot (*Fulica americana*) then frantically beat its wings to withdraw from

the site. Clearly the prey was jettisoned to facilitate "escape," but in this hawk/weasel scenario did the weasel, with a well placed bite, induce the hawk to release it or was the weasel released by the hawk to hasten its departure from the scene? Probably the latter - the limp appearance of the "prey" in the talons of the raptor suggested death rather than aggression, but: if the ermine was the hunted, why did it appear to quickly become the hunter chasing and leaping up at the hawk? It seemed that the predator/prey roles had been dramatically reversed!

Naturalist Dick Decker[13] described a long-tailed weasel (*Mustela frenata*), apparently apprehensive of Decker's presence nearby, repeatedly race outward two or three metres from a burrow, then leaping into the air 70 - 80 cm as it turned and returned to the hole. Decker interpreted this behavior as a defensive/aggressive tactic to dissuadea potential attack by a hawk or owl though there was no known predator about. If Decker is correct, the Dauphin observation of the weasel's actions after release (escape?) were not to exact revenge on the hawk but were a defensive maneuver to discourage a second attack. Could this behavior described by Decker for *M. frenata* now be extended to *M. erminea* pending additional documentation? On the other hand, and much more remotely, had the weasel been the aggressor that had had the tables turned on it, only to be fortuitously spared by our party's arrival?

1. Bent, AC (1961) Life histories of North American birds of prey. Part 1. Dover Publications, New York.

2. Terres, JK (1980) The Audubon Society encyclopedia of North American birds. Alfred A. Knopf, New York.

3. Craighead, FC, Craighead, JJ (1956) Hawks, owls and wildlife. Stackpole Co., Harrisburg, PA.

4. Bent, AC (1961) Life histories of North American birds of prey. Part 2. Dover Publications, New York.

5. Fisher AK (1893) The hawks and owls of the United States in their relation to agriculture. United States Agriculture, Division Ornithology and Mammalogy. Bulletin 3. In: Bent, AC (1961) Life histories of North American birds of prey Part 1. Dover Publications, New York.

6. Schowalter, DB, Engley, L Digby, R (2002) Records of Alberta small mammals through analyses of great horned owl pellets. *Blue Jay* 60: 153 - 167.

7. Gerard, M, K, Zazeleschuk, D (2009) A sample of prey remains found in great horned owl nests in Saskatchewan in 2008. *Blue Jay* 67: 71 - 76.

8. Boxall, PC (1979) Interaction between a long-tailed weasel and a snowy owl. *Canadian Field-Naturalist* 93: 67 - 68.

9. Gross, AO (1944) Food of the Snowy owl. *Auk* 61: 1 - 18.

10. Banfield, AWF (1974) The mammals of Canada. National Museums of Canada, Ottawa.

11. Walley, WJ (1982) Weasel skull in short-eared owl (*Asio flammeus*) pellet. *Canadian Field-Naturalist*. 96: 81.

12. Criddle N, Criddle S (1925) The weasels of southern Manitoba. *Canadian Field-Naturalist*. 39: 142 - 148.

13. Decker, D (2002) Defensive behaviors of long-tailed weasels. *Blue Jay* 60: 115 - 116.

PLANTS

THE LYCOPODS (PHYLUM LYCOPODIOPHYTA); CLUBMOSSES, FIRMOSSES, SPIKEMOSSES AND QUILLWORTS, IN MANITOBA

RICHARD J. STANIFORTH *336 Glenwood Crescent, Winnipeg, MB, R2L 1J9.*
Email: richard_staniforth@yahoo.ca

The lycopods fascinate many of us because they are the most ancient and primitive of all living vascular plants. Fossil relatives are traceable to the swamp forests of the late Carboniferous Period more than 320 million years ago, well before the dinosaurs reached their peak diversity.[1] Although some ancient lycopods were large trees and grew to 55m (165feet) in height,[2] today's species are modest and many superficially resemble large moss plants.[3] The name "lycopod" is derived from the appearance of leafy shoots which are supposed to resemble the feet of wolves![4] Most clubmosses, firmosses and spikemosses in Canada grow in grasslands, on forest floors, or in the forest-tundra, alongside the relatively modern seed-forming plants; the conifers and flowering plants (Fig. 1).[3] Quillworts are an unusual group of lycopods in that they are aquatic or semi-aquatic, and grass-like in appearance (Fig. 1).[3]

We urgently need to catalogue and make range maps for all groups of organisms, such as lycopods, in our provinces, states and countries.[5] The anticipated great changes in climate and landscapes will inevitably result in drastic adjustments in abundances and distributions. It is necessary to obtain as much current baseline data as possible for future reference.[5] Such a study is timely for lycopods because there have been recent changes in their classification and nomenclature.[6] We barely know what species we have!

Materials and Methods

During 2009, 2010 and 2011, I examined all 720 lycopod specimens that had been collected in Manitoba and housed in Manitoba herbaria; the Manitoba Museum (**MMMN**), Universities of Manitoba (**WIN**) and Winnipeg (**UWPG**), and in my own, non-registered collection ("RS"). The identity of each specimen was checked using the identification keys from the Flora of North America and Haines.[6,7] Nomenclature of specimens was updated and annotations were applied when necessary. The collection numbers, locations, habitats, dates and other information were initially recorded in an Excel spreadsheet. Location information were converted to Universal Transverse Mercator (U.T.M.) grid, North American Datum 1983 (N.A.D. 83) values, but only if the herbarium sheet data had been sufficiently precise.

There are several popular ways to illustrate the ranges of species, including the use of dots or shading.[3,7] In this study, a decision was made to show occurrences as dots in the 291 50 x 50 km squares that comprise the U.T.M. grid (N.A.D. 83) for the Province of Manitoba. This is in accordance with plant distribution maps that have been used successfully for plants and other biota in Europe and other parts of the world,[8] and they are anticipated to become more widespread in Canada.[5] It provides a comparative approach in range map presentation. In this study, a distribution map was made

Table 1. Numbers of specimens of lycopods in Manitoba herbaria (MMMN, UWPG, WIN and the author's collection), numbers of UTM squares in which the specimens were collected out of 6068 squares (10X 10 km) and out of 291 squares (50 x 50 km), and rankings according to NatureServe Canada.[9] NatureServe Conservation Status Ranks are: G=Global, S=Subnational (i.e. Province of Manitoba), 1=Very rare, 2= Rare, 3=Uncommon, 4=Abundant with possible known threats, 5=Abundant and secure, NR=Species not ranked.

Common name	Scientific name	Herbarium specimens	10 x 10 km UTM squares occupied	50 x 50 km UTM squares occupied	Conservation Status Rank
Clubmoss family	**Lycopodiaceae**				
Prickly tree clubmoss	*Dendrolycopodium dendroideum*	106	70	30	G5 S5
Hickey's tree clubmoss	*D. hickeyi*	20	19	15	G5 S2
Northern ground-cedar	*Diphasiastrum complanatum*	38	30	24	G5 S5
Sitka clubmoss	*D. sitchensis*	1	1	1	G5 S1
Blue ground-cedar	*D. tristachyum*	14	11	9	G5 S2
Savin-leaved ground-cedar	*D.* x *sabinifolium*	21	20	18	G4 S4
Zeiller's ground-cedar	*D.* x *zeilleri*	58	30	14	GNR SNR
Unidentified ground-cedars	*Diphasiastrum* spp.	40			
Northern bog clubmoss	*Lycopodiella inundata*	3	2	2	G5 S1
Common clubmoss	*Lycopodium clavatum*	41	20	8	G5 S4
One-cone clubmoss	*Lycopodium lagopus*	40	33	20	G5 S4
Common interrupted clubmoss	*Spinulum annotinum*	154	88	46	G5 S5
Canadian interrupted clubmoss	*Spinulum canadense*	42	36	31	GNR SNR
Firmoss family	**Huperziaceae**				
Mountain firmoss	*Huperzia appressa*	7	6	5	GNR SNR
Shiny firmoss	*H. lucidula*	0	0	0	G5 SNR
Northern firmoss	*H. selago*	9	8	7	G5 S2S3
Butters' firmoss	*H.* x *buttersii*	3	2	2	GNR SNR
Spikemoss family	**Selaginellaceae**				
Prairie spikemoss	*Selaginella densa*	16	10	9	G5 S3
Rock spikemoss	*S. rupestris*	78	51	30	G5 S5
Northern spikemoss	*S. selaginoides*	8	6	6	G5 S2
Quillwort family	**Isoetaceae**				
Lake quillwort	*Isoetes lacustris*	6	6	5	G5 S2
Spiny-spored quillwort	*Isoetes echinospora*	15	10	8	G5 S4

for each species; each dot on the map indicated that at least one specimen that had been collected from that particular 50 x 50 km square.

Results and Discussion

Seven hundred and twenty specimens of lycopods were examined. These consisted of four families (clubmosses, firmosses, spikemosses and quillworts; see Fig 1), eight genera, seventeen species and at least three well-established hybrids (Table 1). This table also shows the number of specimens of each species together with their global and provincial conservation status ranks.[9] With few exceptions, lycopods are equally conspicuous, such that a difference in numbers of specimens likely reflected real differences in species abundances. Unfortunately, the same cannot be said of the northern bog clubmoss and northern spikemoss which are both inconspicuous and their apparent rarity may be due to under collection.[3] Similarly, quillworts are easily overlooked, not because of rarity, but because their submerged habitat.

One of the exciting features of studies like this one is the chance that new taxa for the study area may turn up in addition to those that had been previously recorded.[10,11,12] This happened twice; firstly with the recognition of Hickey's tree clubmoss as a Manitoba species (Fig. 2) and secondly that the commonest ground cedar in SE Manitoba was actually the hybrid taxon, Zeiller's ground-cedar (Fig. 5).

Many clubmosses occur in similar habitats to each other with the result that it was not unusual to find several species growing in close proximity. In SE Manitoba; Zeiller's ground-cedar, prickly tree clubmoss, interrupted clubmoss and the common clubmoss often occurred together in the mossy ground floras of mixed forests. With few exceptions, disturbance appeared to be a factor that was detrimental to the longevity of clubmoss colonies. Fires, clearance for agriculture and certain logging practices, such as scarification and trenching, usually resulted in the rapid disappearance of these species from an area. This probably accounted for their scarcity or complete absence from SW Manitoba, Birds Hill Provincial Park,[13] Manitoba's Interlake region, the sandy esker region of NW Manitoba, and so on. In the absence of disturbance, colonies may occupy tens or even hundreds of square metres and reflect the time interval since the last disturbance.

Differences between the lycopod genera; clubmosses, tree clubmosses, the bog clubmoss, ground cedars, interrupted clubmosses, spikemosses, firmosses and quillworts are striking and usually do not cause confusion. On the other hand, differences between species within certain genera are more subtle and can be challenging. Hybridization between species adds a further level of complication to the identification of firmosses and ground-cedars.[3,6,7] For these reasons, an identification key of Manitoba taxa is given; an annotated checklist, and figures are provided to describe provincial distributions and habitats.

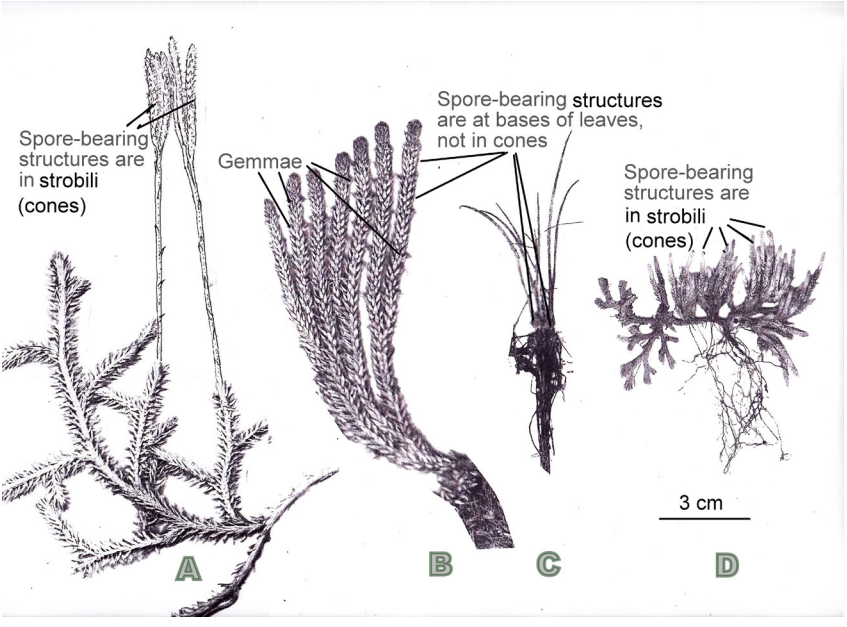


Figure 1. The four families of lycopods found in Manitoba: A. Clubmosses, B. Firmosses, C. Quillworts, D. Spikemosses. Note that the spore-bearing structures, or sporangia, are aggregated into cones or strobili in A. and D. but not in B. and C. Gemmae, or propagating buds, eventually fall from the parent plant and develop into new plants; these are found in B. only.

Key to the families of lycopods found in Manitoba

1a. Plants are terrestrial, creeping with above-ground or subterranean rhizomes (horizontal stems) and upright shoots. The stems are covered by numerous, small, evergreen leaves.…..…**2.**

1b. Plants of Manitoba species are submerged aquatic macrophytes. Each plant has a short, bulbous stem and a crown of long quill-like leaves. ……..... .....…….**Quillworts** (*Isoëtaceae*)

2a. Sporangia are in the axils of specialized leaves (sporophylls), which themselves are clustered at the tips of shoots into strobili (cones). Vegetative propagating buds (gemmae) are absent.....**3.**

2b. Sporangia develop in the axils of ordinary leaves and are not arranged in distinct cones (strobili). Conspicuous gemmae are present on the shoots. ……..... .....… **Firmosses** (*Huperziaceae*)

3a. Plants resemble giant moss plants, much taller than 4 cm. Strobili cylindrical, not flat-sided. The spores are all tiny. …….…….. **Clubmoss family** (*Lycopodiaceae*)

3b. Plants resemble tiny moss plants, rarely over 4 cm tall. Strobili (cones) are 4-sided (or cylindrical in the rare Northern spikemoss). Sporangia with two-kinds of spores; large megaspores and tiny microspores ……..... .....…… **Spikemosses** (*Selaginellaceae*)

Key to genera and species of clubmosses found in Manitoba

1a. Plants; small creeping annual with strobili (cones) clothed with green leaves and resemble "bushy tails" ……. *Lycopodiella inundata*
1b. Plants; robust, perennial and evergreen with cylindrical strobili. These are clothed with sporophylls (scales) not resembling the normal leaves ……..…….. **2.**

2a. Youngest shoots, incl. leaves; 5 to 12 mm wide; round in cross-section; leaves many ranked on stems ……..… **3.**
2b. Youngest shoots, incl. leaves; 2 to 6 mm wide, flat in cross-section (except in *D. sitchense*); leaves 4-ranked (or 5-ranked in *D. sitchense*) on stem ……
……..…..... *Diphasiastrum* (go to **8**)

3a. Stems tree-like, with single vertical axis and numerous horizontal branches.....
……. ……..... *Dendrolycopodium* (go to **4**)
3b. Stems not tree-like, but creeping along surface of ground and giving rise to numerous upright branches …….....**5.**

4a. Leaves of main stem below the branches stand at right angles to stem. The main stems feel prickly to touch. ……..*Dendrolycopodium dendroideum*
4b. Leaves of main stem below the branches are incurved. The main stems feel smooth to touch. ……..…… *Dendrolycopodium hickeyi*

5a. Strobili sessile (without stalks); leaves bristly and prickly to touch; annual growth increments are made conspicuous by constrictions amongst the stem leaves ……..……*Spinulum* (go to **6**)
5b. Strobili on long stalks; leaves soft and hair-tipped, not prickly; the annual growth increments are not highly conspicuous ……...…… *Lycopodium* (go to **7**)

6a. Leaves 3.0 to 5.9 mm long, usually not toothed. Leaves located above each annual constriction are broadest near their bases. Leaf clearly margins are not toothed or are only obscurely toothed. Strobili 0.8 to 1.7 cm...…….....……*Spinulum canadense*
6b. Leaves 5.2 to 9.8 cm long, usually clearly toothed. Leaves located above each annual constriction are widest near or above their middles. Leaf margins are clearly toothed. Strobili 1.7 to 4.3 cm long. ……... *Spinulum annotinum*

7a. Strobili one (occasionally 2) per stalk; above-ground stems with few (usually 3 or less) upright branches ……..……..... *Lycopodium lagopus*
7b. Strobili 2-4 (rarely single) per stalk; above-ground stems with many spreading branches ……..…… *Lycopodium clavatum*

8a. Branches flat; tiny leaves attached to the branches for most of their lengths. The leaves are in four rows on the branches, i.e. above, below, and on the two sides of the branches ……..…… **9.**
8b. Branches slightly flattened to round in section; leaves attached to the stems only at their bases and in four or five rows ……..……...……**11.**

9a. Horizontal stems on or near soil surface, but often under moss or leaf litter; peduncles with 1 (occasionally 2) strobilus ……. *Diphasiastrum complanatum*
9b. Horizontal stems subterranean; peduncles with 2 or 4 strobili …….…… **10.**

10a. Branchlets flat and wide (> 2mm) ventral leaves about half the lengths of dorsal leaves; foliage glossy, dark green…… *Diphasiastrum* x *zeilleri*) (The Zeiller's ground-cedar is common in SE Manitoba and is often confused with one of its parents, northern ground-cedar, from which it differs by its subterranean stems and because it has 2-4 strobili per peduncle. The other parent species is the blue ground-cedar.)
10b. Branchlets flat but narrow (< 2mm), almost cord-like; ventral leaves almost as long as dorsal leaves; foliage with bluish appearance ….…… *Diphasiastrum tristachyum*

11a. Strobili sessile to short (< 1 cm) stalked; when present, peduncles (stalks) do not possess fertile sporophylls along their lengths …….. *Diphasiastrum sitchense*
11b. Strobili stalked, the upper parts of the peduncles have scattered sporophylls containing sporangia…….. *Diphasiastrum* x *sabinifolium*
(The savin-leaved ground-cedar is the hybrid between the blue and Sitka ground-cedars and is quite variable. Plants reflect various proportions of characters of each parent species.)

Key to species of firmosses found or expected to be found in Manitoba
1a. Leaves toothed; dark green, shiny; parallel sided to widest above middle. Stems with conspicuous annual constrictions. Usually found in shady woods..…….**2.**
1b. Leaves not toothed; parallel sided to widest at base; yellow, yellowish-green or green, shiny or dull. Usually found in open sites e.g. rock outcrops, bogs or wet tundra. ……..**3.**

2a. Leaves broadest above their middles with conspicuous teeth on the leaf margins; spores in sporangia spherical and healthy..…….. *Huperzia lucidula*
2b. Leaves parallel sided with few or tiny teeth on the leaf margins; spores in sporangia misshapen and aborted..…… *Huperzia* x *buttersii*

3a. Gemmae (vegetative buds) are arranged in single whorls (rings), each located at the apex of an annual growth segment.....…….. *Huperzia selago*
3b. Gemmae are arranged in several whorls at the apex of each growth segment of the stem, or scattered throughout the stem ……...*Huperzia appressa*

Key to spikemosses found in Manitoba
1a. Leaves pointed but not bristle-tipped, strobilus cylindrical, sporophylls spreading. Rare plant of alkaline fens and damp areas.....*Selaginella selaginoides*
1b. Leaves bristle-tipped. Strobilus square in cross-section, sporophylls appressed. Common plants of dry rocks and sandy soils ……..……..**2.**

2a. Plants form dense, tufted clumps. Shoot tips appear to be upturned and with a distinct, terminal brush of leaves when dry. Fresh shoots appear silvery and frosty-tipped because of the concentrations of bristle-tipped leaves…… *Selaginella densa*
2b. Plants form loose clumps or spreading. Shoot tips appear to be straight and without dense terminal brushes of leaves when dry. Fresh shoots appear green……..... .....*Selaginella rupestris*

Key to species of quillworts found in Manitoba

1. Leaves curved outwards, yellow-green and tapering gradually towards their tips. Megaspores covered by short spines. Usually found in lakes and slow rivers that are < 1.5m deep.…….....*Isoëtes echinospora*

2. Leaves more or less, straight and upright, dark-green, abruptly tapered at their tips. Megaspores covered with ridges but possessing a girdle of short spines. Usually found in lakes that are 1.5m or more deep.....…… *Isoëtes lacustris*

Annotated checklist of Lycopods found in Manitoba

1. Prickly tree clubmoss, *Dendrolycopodium dendroideum* (Michx.) A. Haines (Fig. 2)

Prickly tree-clubmoss is the common tree clubmoss in Manitoba. It inhabits moist mixed and coniferous forests, throughout the province except the agricultural southwest. It often co-occurs with other clubmosses, such Common and Interrupted clubmosses. It is common in boreal regions of Saskatchewan including Cypress Hills.[4] Tree club-mosses, or Ground-pines, have vertical stems that are branched in the fashion of small trees. This species has leaves on the main stem that are held at right angles to it and give a prickly sensation to touch. Older texts refer to this species as *Lycopodium obscurum* L.

2. Hickey's tree clubmoss, *Dendrolycopodium hickeyi* (W.H. Wagner, Beitel & Moran) A. Haines (Fig.2)

This is the first report of the Hickey's tree-clubmoss for Manitoba, where it's distribution and habitats are somewhat similar to those of the commoner Prickly tree club-moss. There is a single record of this species from Lake Athabasca in northwest Saskatchewan.[4] In this species, the main stem feels smooth because its leaves are appressed to it.[6,14,15,16] The two species of tree club-mosses have been found growing within 5 metres of each other in the SE Manitoba and yet had maintained their differences. It was formerly called *Lycopodium obscurum* variety *isophyllum* Hickey.

3. Northern ground-cedar, *Diphasiastrum complanatum* (L.) Holub (Fig. 3)

This species is common and widespread in Manitoba. It is found in the understory of several forest types from moist mixed to open dry pine/spruce woodland. It occurs throughout the boreal forest region of Saskatchewan and in the Cypress Hills.[4] The common hybrid, Zeiller's ground cedar, has often been mistakenly identified as this species, especially in SE Manitoba. The northern ground cedar differs from the hybrid by having horizontal stems at or near the ground surface and peduncles with single strobili. This species was formerly called *Lycopodium complanatum*.

4. Sitka clubmoss, *Diphasiastrum sitchense* (Rupr.) Holub (Fig. 3)

Manitoba's single specimen of Sitka ground cedar was collected by E. Punter in NE Manitoba in July, 1991 (WIN 52607).[10] This plant had been growing on mineral soil amongst short black spruce trees in an area, recovering from fire damage. The Sitka - Savin-leaved ground cedar complex is represented by scattered colonies across the northern half of Saskatchewan.[4] The species was formerly known as *Lycopodium sitchense*.

5. Blue ground-cedar, *Diphasiastrum tristachyum* (Pursh) Holub (Fig.4)

The Blue ground-cedar is rare but occurs in a band of colonies from SE to mid-West Manitoba. It inhabits dry rock outcrops and sand hills in pine forests within the boreal forest region. It has not been reported from Saskatchewan.[4] Compared to the Northern ground cedar, plants of this species differ by the bluish bloom on their foliage, subterranean rhizomes, fan-shaped arrangement of the narrow branches, prominent lower leaves and multiple strobili per peduncle. This species was formerly called *Lycopodium tristachyum*.

6. Savin-leaved ground-cedar, *Diphasiastrum* x *sabinifolium* (Willd.) Holub (*D. sitchense x D. tristachyum*) (Fig. 4)

This is the commonest ground-cedar in northern Manitoba where it is found in open spruce or pine forests, eskers or on rocky outcrops. The Sitka-Savin-leaved ground-cedar complex occurs as scattered colonies in northern Saskatchewan.[4] Despite its hybrid origin, it may occur where one or both parent species are absent. Adjacent colonies may have different appearances; each with a set of attributes typical of one parent more than the other. Colonies form self-sustaining fertile populations. The presence of fertile, sporangia-bearing sporophylls below the strobili is a unique characteristic of this taxon. This hybrid was formerly known as *Lycopodium* x *sabinifolium*.

7. Zeiller's ground-cedar, *Diphasiastrum* x *zeilleri* (Rouy) Holub (*D. complanatum* x *D. tristachyum*) (Fig. 5)

This is the commonest ground-cedar in SE Manitoba, where it is found on moist well-drained soils in mixed and coniferous forests. It is scarce elsewhere. This is the first report for Manitoba, because it has usually been misidentified as Northern ground-cedar. Zeiller's ground-cedar has been reported from pine forests in N Minnesota,[3,7] but not from Saskatchewan.[17] It is a hybrid of the northern and blue ground-cedars; forming self-sustaining fertile populations often far from either parent species. It is characterized by the presence of subterranean shoots and multiple cones typical of the blue ground cedar, but bearing tiny ventral leaves and wide shoots of its other parent, the northern ground-cedar.

Unidentified (vegetative) ground-cedars, *Diphasiastrum* spp.

Many specimens of ground-cedars were not fertile when collected and accurate identifications could not be made. Many appear to belong to the northern-blue-Zeiller's ground-cedar complex.

8. Northern bog clubmoss, *Lycopodiella inundata* (L.) Holub (Fig. 5)

Northern bog club-moss was collected by E. Punter from Nopiming Provincial Park, E. Manitoba in July, 1993 (WIN 55084, WIN 55312).[10] In 2010, I found the site flooded and bog club-mosses were absent. In 2010, E. Punter discovered an unaccessioned 1996 collection from Singleton Lake, N Manitoba (WIN). It occurs at scattered locations in N Saskatchewan, and is listed as "vulnerable".[17] The tiny plants of this annual species are easily overlooked. It should be searched for in wet, sandy, open sites within the boreal forest in mid to late summer. This species was once known as *Lycopodium inundatum* L.

9. Common clubmoss, *Lycopodium clavatum* L. (Fig. 6)

The Common, Running or Stag's-horn clubmoss is locally common in undisturbed, mixed and coniferous forests in SE Manitoba. It is found in similar habitats to the closely related, but more widespread One-cone clubmoss. Both have leaves which terminate in a fine hair and both form extensive colonies by means of their spreading horizontal stems. The most obvious difference between the two species is that the Common clubmoss has cones that are arranged in 2-4 per peduncle, whereas shoots of its sibling species usually have single cones. The Common clubmoss is of uncertain status in Saskatchewan owing to its confusion with the One-cone clubmoss.[4]

10. One-cone clubmoss, *Lycopodium lagopus* (C. Hartman) G. Zinserling *ex* Kuzeneva-Prochorova (Fig. 6)

This boreal forest species is found from SE to NW Manitoba. It is more widespread and northern than the Common clubmoss and is more often found near rock outcrops. The species is common throughout the boreal forest region of Saskatchewan.[4] It was once considered to be a variety of the Common clubmoss, i.e. *L. clavatum* L. var. *monostachyon* Hook. & Grev.[3,11,12] however, it maintains its differences even when growing in the same vicinity,[7] as they often do in SE Manitoba. Apart from its single strobili, this species differs by having fewer branches on its upright shoots than does the Common clubmoss.

11. Common interrupted clubmoss, *Spinulum annotinum* (L.) A. Haines (Fig. 7)

This species is the most abundant and widespread clubmoss in Manitoba. In common with several other clubmosses; it is found in moist, mixed and coniferous woodlands with organic soils. It is also common throughout the boreal forest region of Saskatchewan.[4] Its upright stems have a distinctive stiff, bristly appearance. The sharp-pointed, shiny leaves are interrupted at intervals along the stems indicating different growth seasons and "interrupt" the outline of the shoots. Leaf shape and degree of marginal dentition is quite variable. Upright stems are branched at the base and produce single, sessile cones at their apices. This species was formerly known as *Lycopodium annotinum* L.[6]

12. Northern interrupted clubmoss, *Spinulum canadense* (Ness.) A. Haines (Fig. 7)

This newly described species is the northern counterpart of the previous one.[6] In Manitoba, the plants inhabit forest-tundra and tundra habits, or barrens within the boreal forest. Vertical shoots may appear to be tufted because they emerge at intervals from the horizontal shoots that are buried under moss or lichen mats. The leaves are shorter, thicker, more triangular, and more appressed than those of the former species. This species was once known as *Lycopodium annotinum* L. var. *pungens* (La Pylae) Desv.[3,11,12]

Annotated checklist of firmosses (Family Huperziaceae)

1. Mountain firmoss, *Huperzia appressa* (Desv.) A. & D. Löve (Fig. 8)

This species is rare in both Manitoba and Saskatchewan. It has been found on moist sedge- heath tundra and in open black spruce bogs along the coastal Hudson Bay Lowlands. Mountain firmoss is sometimes difficult to separate from the next species from which it differs mostly by habitat and the location of gemmae.[6] The latter are found throughout the lengths of the shoots rather than solely at the ends of annual growth

increments. The entire plant turns yellow upon reaching maturity, before senescence occurs. This species was once considered part of the variation within the former species, *Lycopodium selago* L.

2. Shining firmoss *Huperzia lucidula* (Michx.) Trev.
There are currently no specimens of Shining firmoss in Manitoba herbaria; however, a specimen is reported to have been collected by J. Ritchie from near the East gate of Riding Mountain National Park.[18] The whereabouts of this specimen is unknown, but a photograph is filed at the Dept. of Agriculture in Ottawa. It shows a non-fertile plant; unfortunately photographic definition is inadequate to allow necessary evaluation of leaf features and thus separate it from the otherwise similar interrupted clubmoss. The Shining fir-moss should be excluded from the provincial list until there is concrete evidence of its occurrence in the province. The species is found in adjacent parts of Ontario and Minnesota.[7,19] Hybrids with Northern firmoss have been collected in Manitoba, near the Ontario border. It is absent from Saskatchewan.[17]

3. Northern firmoss, *Huperzia selago* (L.) Bernh. ex Schrank & Mart. (Fig. 8)
There have been few colonies of this species discovered in Manitoba. They were located in the boreal forest at well-separated locations in the eastern and northern parts of the province. Most specimens had been collected from damp, shady granite outcrops or boulder slopes. Apart from habitat dissimilarities, this species varies from the mountain firmoss in the locations of its gemmae on its stems; see above. Specimens from northern Manitoba maybe hybrids with Mountain firmoss, i.e. *H.* x *josephbeitelii* A. Haines, but there is an urgent need for more taxonomic study on all Manitoba firmosses.[3] The northern firmoss is "vulnerable" in both Manitoba and Saskatchewan.[17]

4. Butters' firmoss, *Huperzia* x *buttersii* (Abbe) Kartesz & Gandi (*H. lucidula* x *H. selago*) (Fig. 9)
Only three specimens of Butters' firmoss have been collected in Manitoba. Although this is a hybrid taxon, it apparently does not need the close proximity of either parent species. The three specimens had been collected from mixed and conifer forests in the SE corner of the province from amongst boulders, or on rock outcrops, in the vicinity of bogs. It has tiny teeth on the leaf margins; flat, parallel-sided leaves, and large gemmae which are arranged at the apices of annual stem growth increments, but it lacks the conspicuous teeth and obovate shapes of the leaves of the shining firmoss. This taxon has not been reported from Saskatchewan,[4] but has been found in adjacent parts of Minnesota.[19]

Annotated checklist of Spikemosses (Family Selaginellaceae)
1. Prairie spikemoss, *Selaginella densa* Rydberg (Fig. 9)
The Prairie spikemoss is restricted to the prairies of southwest Manitoba; however, recently colonies have been found in the Interlake region on calcareous bedrock, and also east of Lake Winnipeg on granitic outcrops. It is usually associated with sparsely vegetated, sandy prairies amongst xerophytic lichens and mosses. Rock and Prairie spikemosses are easily confused. The length of the bristle at the leaf apex is usually given as the diagnostic character, but as Scoggan has pointed out, this feature is unreliable **Scoggan**. A far better guide is to examine the branch tips which are densely tufted in the Prairie spikemoss but not so in the other species. It is very common in southern Saskatchewan.[4]

2. Rock spikemoss, *Selaginella rupestris* (L.) Spring (Fig. 10)

This is a common species in eastern and mid-latitudes of Manitoba. It occurs on granitic outcrops with hair-mosses (*Polytrichum* spp.) and lichens, but it is also found in sandy, grassy places, and openings in pine forests. Its abundance on road allowances that pass through pine forests may indicate a tolerance of moderate disturbance and the ability to quickly exploit new sites. It is common on rock outcrops in the boreal forest of northern Saskatchewan.[4] The small size of this and the preceding species make them easy to overlook amongst superficially similar mosses with which they are often associated. The spike-like strobili of spikemosses should separate them from mosses with ease.

3. Northern spikemoss, *Selaginella selaginoides* (L.) P. Beauv. (Fig. 10)

Plants of Northern spikemoss are small, inconspicuous and very difficult to spot amongst associated mosses. There have been few collections, which may suggest that it has been overlooked. As in Saskatchewan, this species occurs in two separate regions where it inhabits different ecosystems.[4] In the Hudson Bay Lowlands of northern Manitoba it is found on wet, mossy, stream banks and lake shores, but in southern Manitoba it is more likely to be found in mossy calcareous fens and fen-bogs. It is provincially rare in Saskatchewan.

Annotated checklist of Quillworts (Family Isoëtaceae)

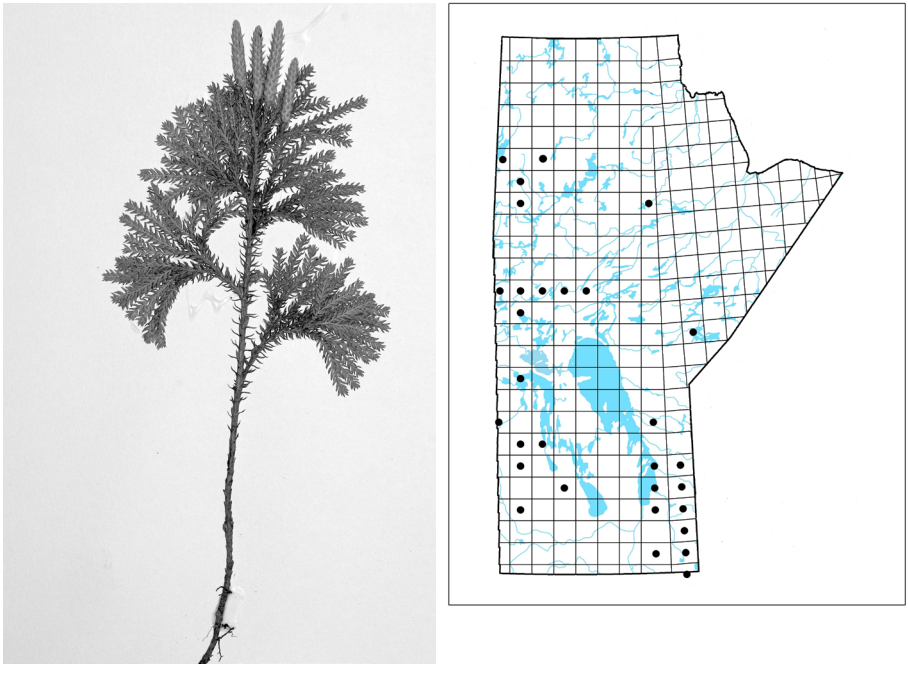
1. Spiny-spored quillwort, *Isoëtes echinospora* Dur. (Fig. 11)

The Spiny-spored quillwort is quite similar in appearance to the next species. It has been collected from shallow ponds, lakes or slow-running rivers in boreal ecosystems in E and N Manitoba. It often occurs in water less than 1 metre deep and sometimes can be seen from the shoreline but more likely seen after storms when uprooted plants are washed ashore. There are few collections from Manitoba, thus making its provincial distribution under-represented. This species tends to have yellower leaves which taper from their bases to the points, and the salt grain sized megaspores have spiny coverings. It is classified as uncommon in Saskatchewan.[4]

2. Lake quillwort, *Isoëtes lacustris* L. (Fig. 11)

There are few collections of Lake quillwort from Manitoba. This species occurs in low-nutrient lakes with sand or mud bottoms and submersed to depths up to 3 m. Its presence is usually only discovered when uprooted plants are washed ashore after storms. Fragmented leaves are grass-like and resemble those of many other aquatic plants. Quillwort leaves have distinctive spoon-shaped leaf bases which may contain the reproductive spores.[3,14] In this species, the leaves tend to be dark green, upright and only taper at the tip. Its megaspores do not have spiny processes on their surfaces, characteristic of the next species. It is rare in Saskatchewan where it has been found at three locations, all north of 58° latitude.[4]

Figs. 2-11. Photographs and distribution maps of lycopods in Manitoba. Photographs were taken by the author, and the original maps were made by Colin Murray.



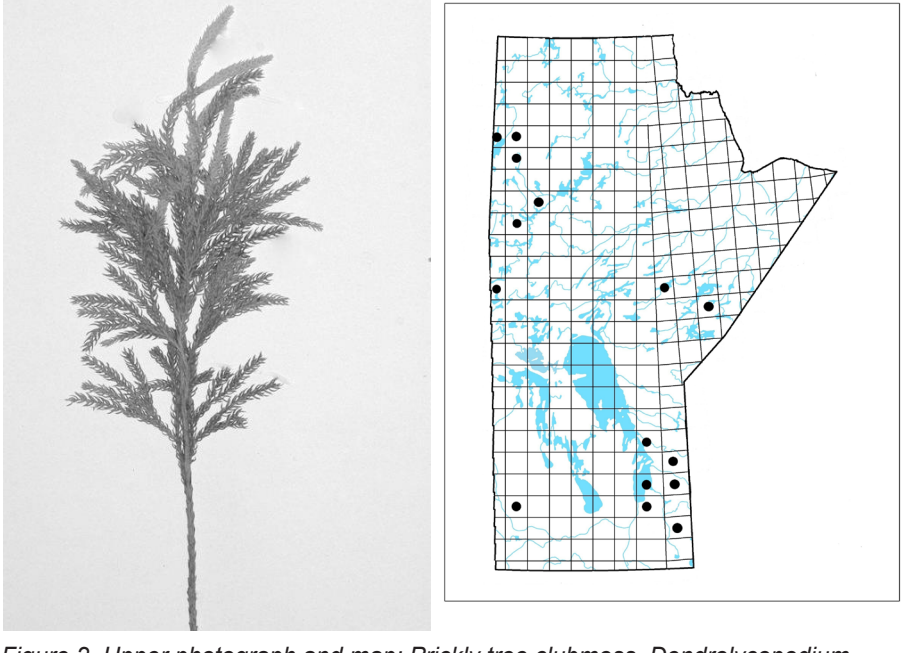
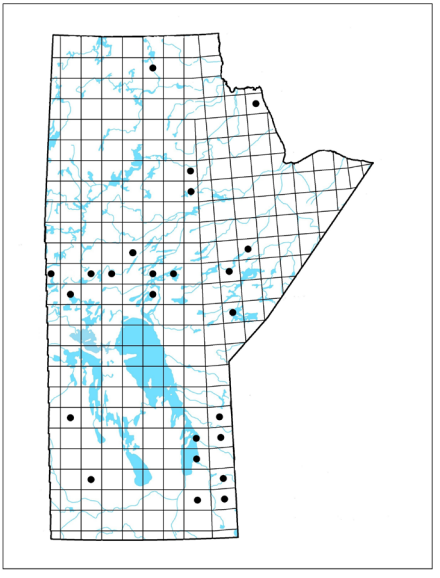
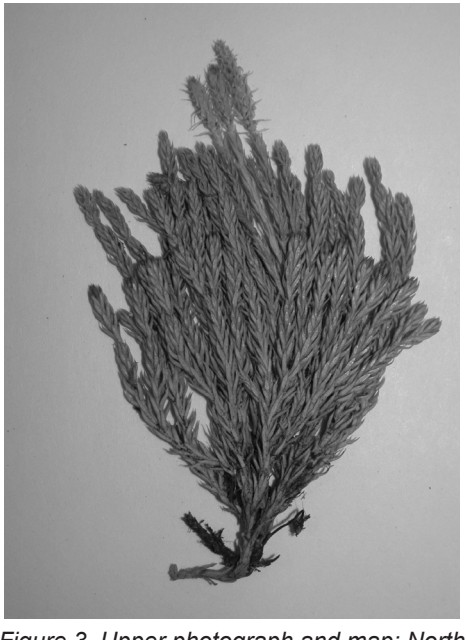


Figure 2. Upper photograph and map: Prickly tree clubmoss, Dendrolycopodium dendroideum. Lower photograph and map: Hickey's tree clubmoss, Dendrolycopodium hickeyi.





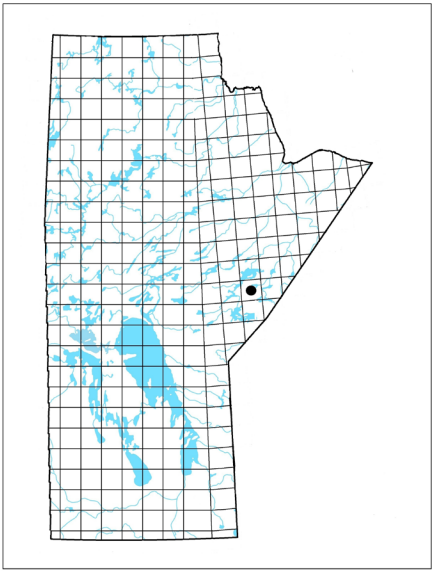
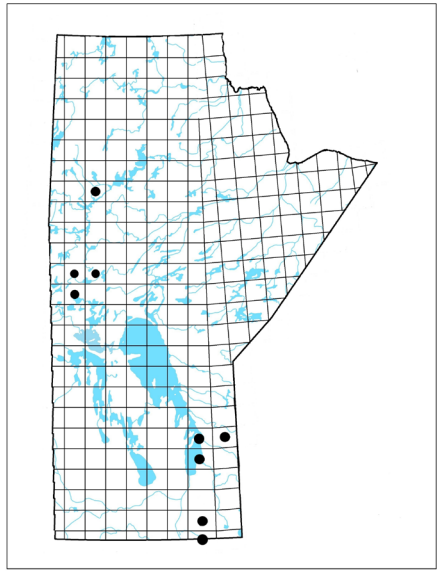
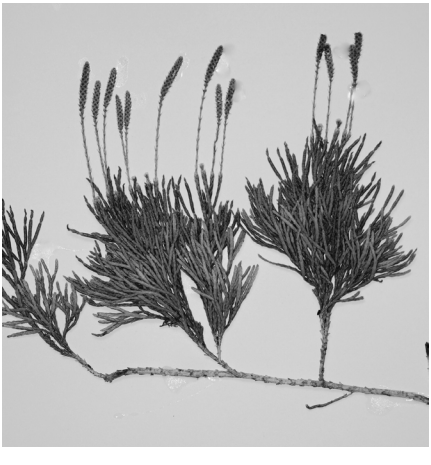


Figure 3. Upper photograph and map: Northern ground-cedar, Diphasiastrum complanatum. Lower photograph and map: Sitka clubmoss, Diphasiastrum sitchense.





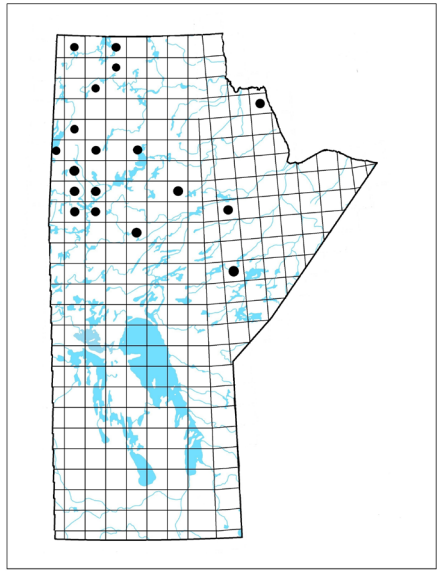


Figure 4. Upper photograph and map: Blue ground-cedar, Diphasiastrum tristachyum. Lower photograph and map: Savin-leaved ground-cedar, Diphasiastrum x sabinifolium.

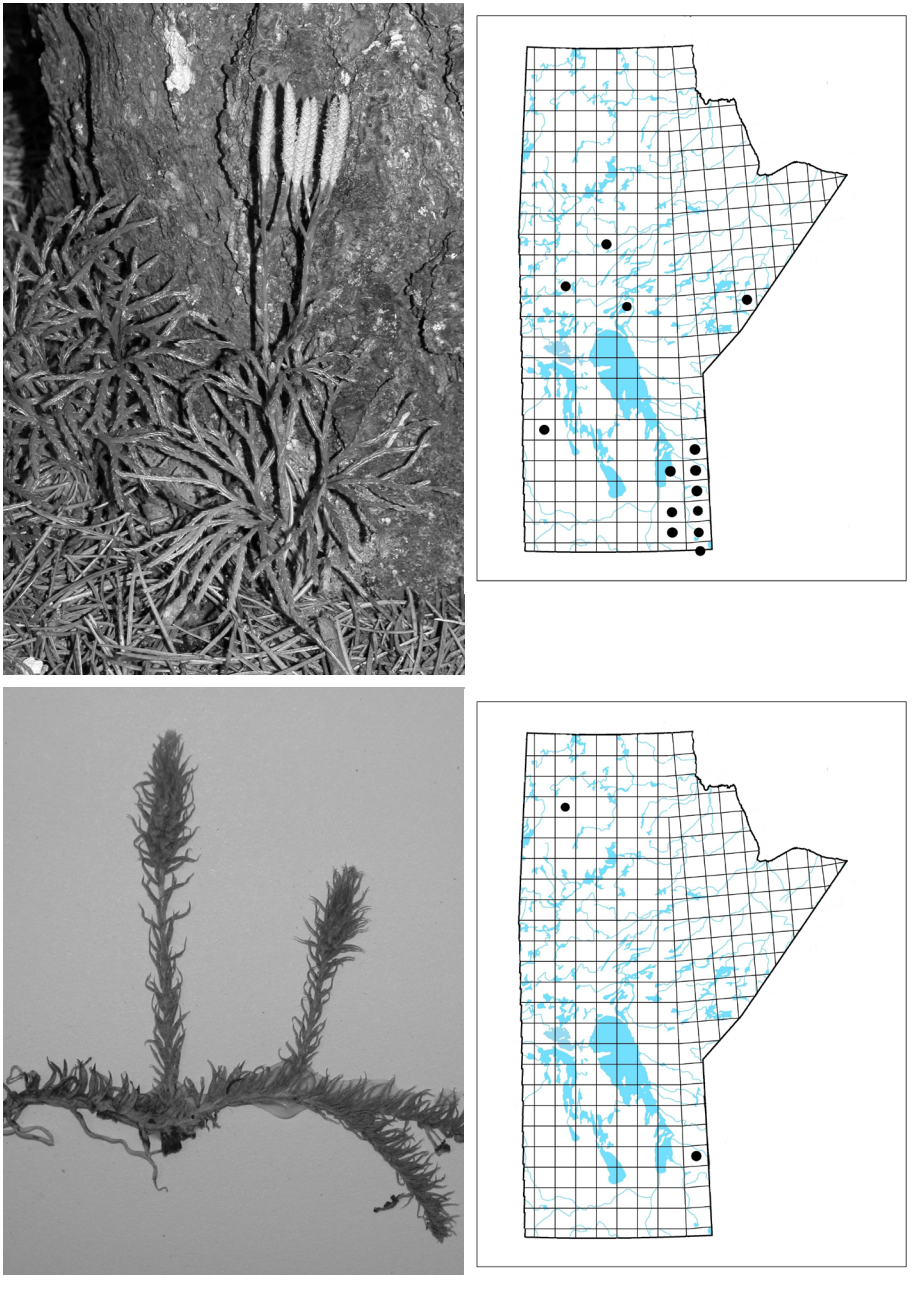
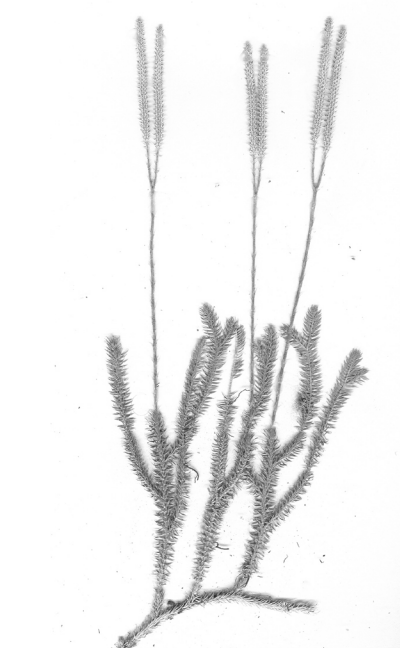
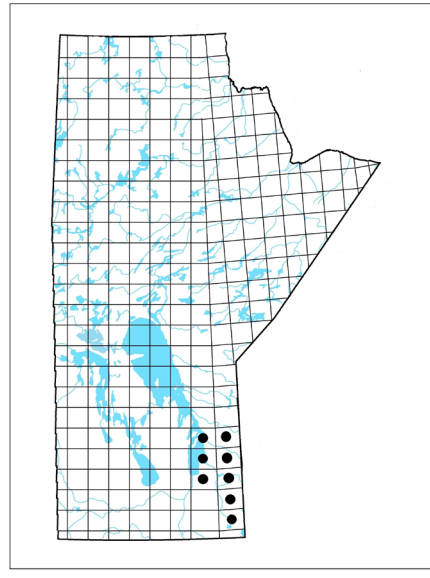


Figure 5. Upper photograph and map: Zeiller's ground-cedar, Diphasiastrum x zeilleri. Lower photograph and map: Northern bog clubmoss, Lycopodiella inundata.





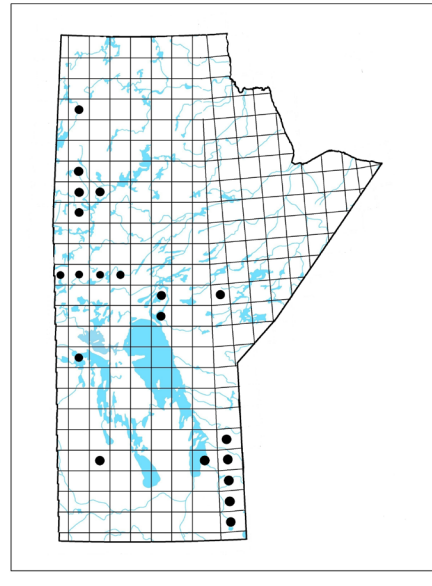


Figure 6. Upper photograph and map: Common clubmoss, Lycopodium clavatum. Lower photograph and map: One-cone clubmoss, Lycopodium lagopus.

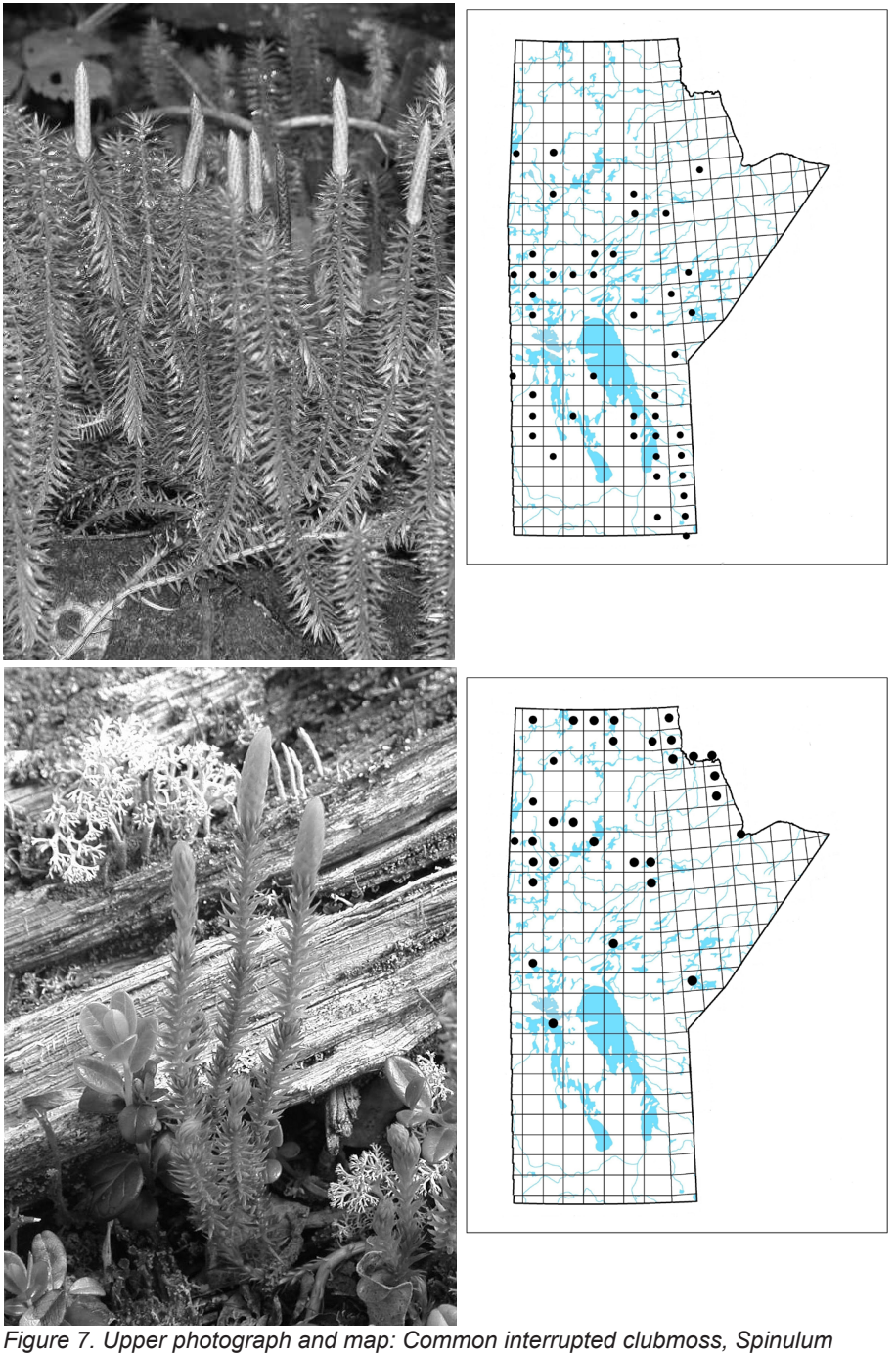
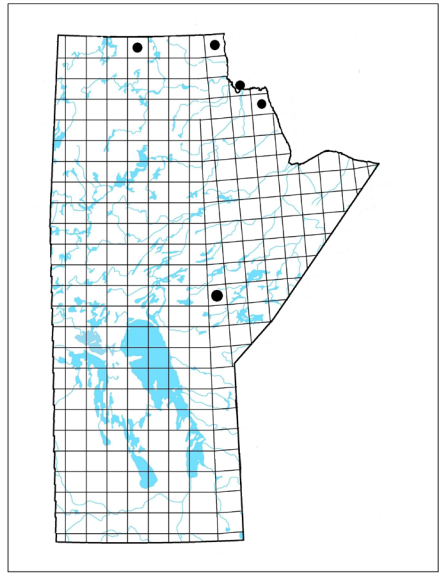


Figure 7. Upper photograph and map: Common interrupted clubmoss, Spinulum annotinum. Lower photograph and map: Northern interrupted clubmoss, Spinulum canadense.



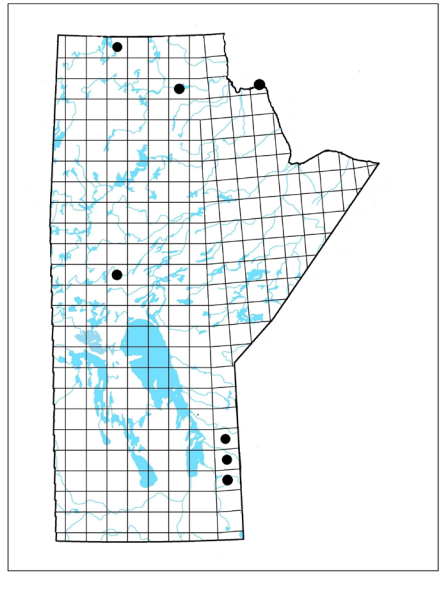
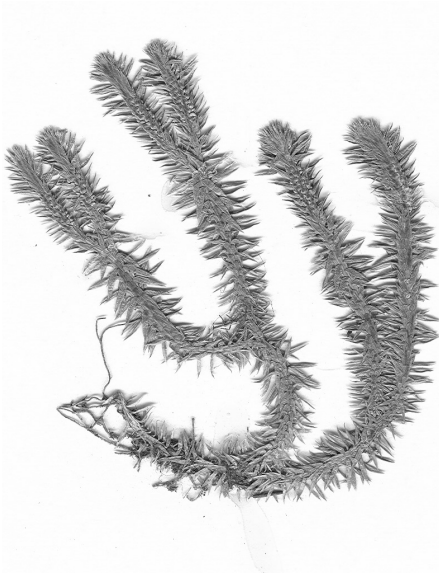
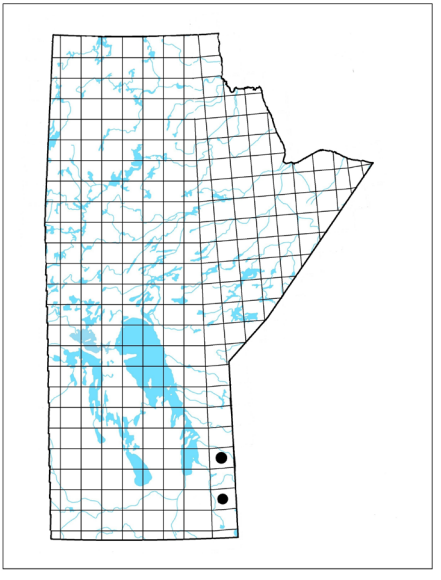


Figure 8. Upper photograph and map: Mountain firmoss, Huperzia appressa. Lower photograph and map: Northern firmoss, Huperzia selago.





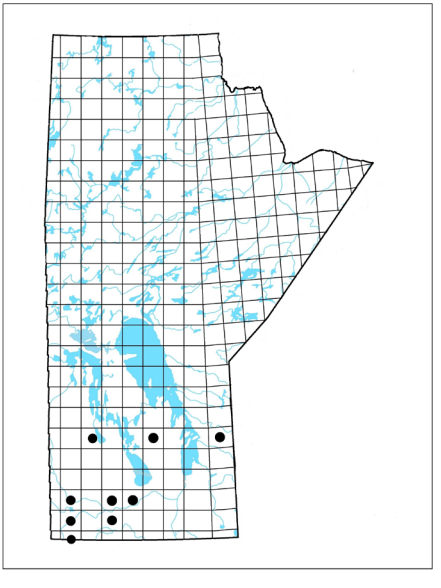
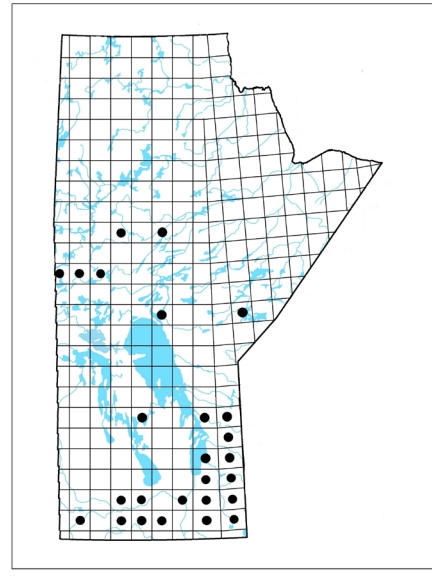


Figure 9. Upper photograph and map: Butters' firmoss, Huperzia x buttersii. Lower photograph and map: Prairie spikemoss, Selaginella densa.



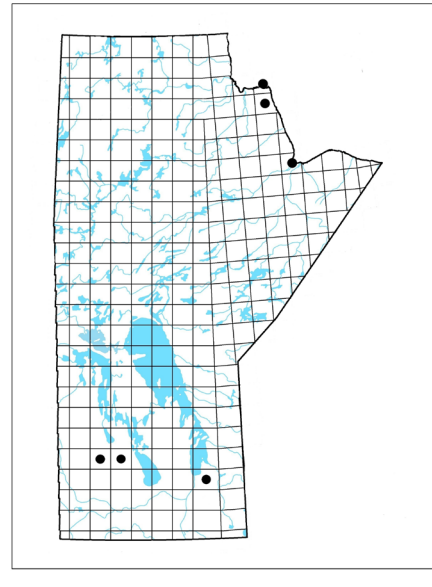
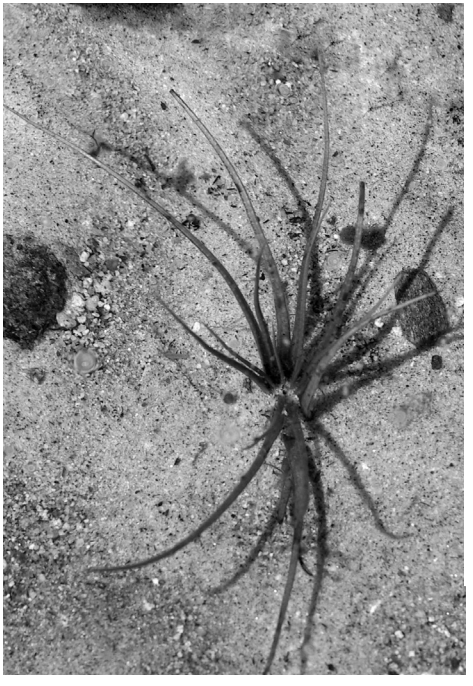
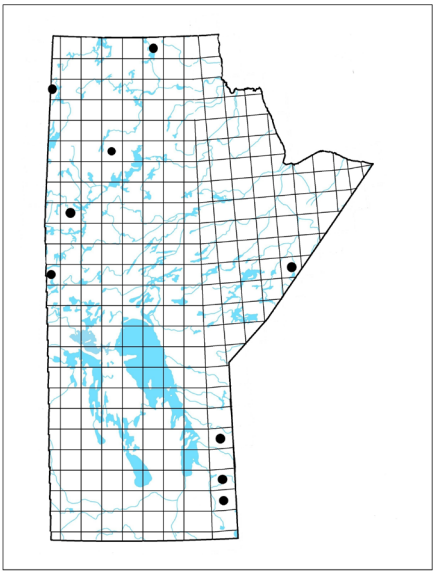


Figure 10. Upper photograph and map: Rock spikemoss, Selaginella rupestris. Lower photograph and map, Northern spikemoss, Selaginella selaginoides.





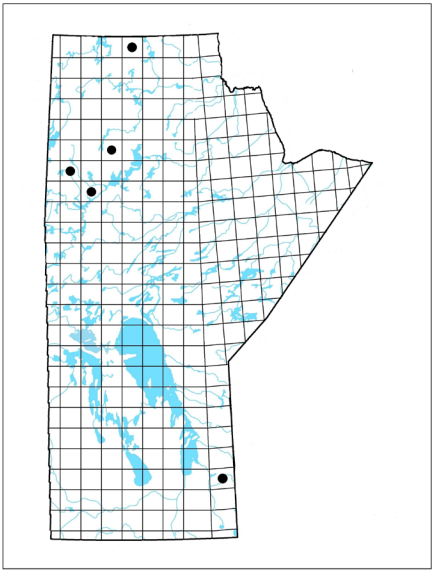


Figure 11. Upper photograph and map: Spiny-spored quillwort, Isoëtes echinospora. Lower photograph and map: Lake quillwort, Isoëtes lacustris.

Acknowledgements

I am grateful to Diana Bizecki Robson and Janis Klapecki, Bruce Ford and Elizabeth Punter and German Avila-Sakar for their encouragement and access to the plant collections at The Manitoba Museum, The University of Manitoba and University of Winnipeg, respectively. Special thanks go to Colin Murray for his patience and expertise in drafting the original distribution maps. Chris Friesen and staff at the Manitoba Conservation Data Centre helped locate specimens that I was unable to find and gave advice with Conservation Status Ranks. Finally, thanks go to Jessica Elliott of Parks Branch, Manitoba Conservation for facilitating collection permits for Provincial Parks.

1. Judd WS, Campbell CS, Kellogg EA, Stevens PF, Donaghue MJ (2002) Plant systematics. A phylogenetic approach. 2nd edn. Sinauer Associates, Inc. Sunderland, MA.

2. Moran RC (2004) A natural history of ferns. Timber Press, Inc. Portland, OR.

3. Cody WJ, Britton DM (1989) Ferns and fern allies of Canada. Publication 1829/E. Research Branch, Agriculture Canada, Ottawa, ON.

4. Harms VL and Leighton AL (2011) Ferns and fern allies of Saskatchewan. Flora of Saskatchewan Fascicle 1. Nature Saskatchewan Special Publication #30. Publ. by Flora of Saskatchewan Association and Nature Saskatchewan. Regina. SK.

5. Staniforth RJ (2011) Ophioglossid ferns in Manitoba: moonworts, grapeferns and northern adder's-tongue. *Blue Jay* 69(2) 75-87.

6. Haines A (2003) The families Huperziaceae and Lycopodiaceae of New England: A taxonomic and ecological reference. VF Thomas Company, Bowdoin, ME.

7. The Flora of North America Association (1993) Flora of North America, Vol 2: Pteridophytes and Gymnosperms. Oxford University Press, Inc. New York, NY.

8. Online atlas of the British and Irish flora. (2012) Available at: http://www.brc.ac.uk/plantatlas/

9. NatureServe (2010) NatureServe Explorer: an online encyclopedia of life [web application]. Version 6.0. NatureServe, Arlington, VA. Available at http://ww.natureserve.org/explorer

10. Punter E (1995) Manitoba's vascular plants. Manitoba Conservation Data Centre, Winnipeg, MB.

11. Scoggan HJ (1957) Flora of Manitoba. National Museum of Canada. Bulletin No. 140. Biological series No. 47. Department of Northern Affairs and National Resurces, Ottawa, ON.

12. Scoggan HJ (1977) The flora of Canada. Part 2 Pteridophyta, Gymnospermae, Monocotyledoneae. National Museum of Natural Sciences. Publications in botany, No. 7(2). National Museums of Canada, Ottawa, ON.

13. Holland G, Ottenbreit K, Punter D, Punter E, Shanks A, Staniforth R (1996) Wild plants of Birds Hill Provincial Park, Manitoba, Canada. Manitoba Naturalists Society, Eco Series 4. Winnipeg, MB.

14. Cobb B, Farnsworth E, Lowe C (2005) A field guide to the ferns and their related families. Northeastern and Central United States. 2nd edn. The New England Wildflower Society. The Peterson Field Guide Series. Houghton Mifflin Company, New York, NY.

15. Hickey RJ (1977) The *Lycopodium obscurum* complex in North America. American Fern Journal 67:45-48.

16. Holub, J (1975) *Diphasiastrum*, a new genus in Lycopodiaceae. Preslia 14: 97-100.

17. Harms VL (2003) Checklist of the vascular plants of Saskatchewan and the provincially and nationally rare native plants in Saskatchewan, including important synonyms, authorities, common names and various status indicators. University Extension Press, Saskatoon, SK

18. Cody WJ (1988) Plants of Riding Mountain National Park, Manitoba. Research Branch, Agriculture Canada, Publication 1818/E, Supply and services Canada, Ottawa, ON.

19. Tryon RM Jr (1954) The ferns and fern allies of Minnesota. University of Minnesota Press, Minneapolis, MN.

ECOSYSTEMS

THE UKRAINIAN STEPPE: STATUS, THREATS AND PROMISES OF SUSTAINABILITY

VLADIMIR V. KRICSFALUSY *School of Environment and Sustainability, University of Saskatchewan, 330 Kirk Hall, 117 Science Place, Saskatoon SK S7N5C8, Canada vladimir.k@usask.ca*

INTRODUCTION

Grasslands and savannas are found in most terrestrial ecoregions of the world and they cover over 40% of the land surface.[1] Following the Pleistocene ice ages, grasslands expanded in range in the hotter and drier climates. Eventually, they became the dominant land feature worldwide. Nowadays, grasslands occupy more of the earth's surface than the other major cover types, i.e. forests or agricultural lands. Along with this huge sweep of area, grasslands are an immensely important environment for humans, plants and animals.

Grassland communities are characterized by rich biodiversity. The vegetation is dominated by grasses and other graminoids such as sedges. Grasses and many sedges are particularly suited for the specific ecological conditions because they have intercalary meristems that allow for continued growth under a grazing regime and help ensure survival in dry summers and cold continental winters. Most grassland plants also have a well-developed fibrous root system with a large surface area, a characteristic which is important under the condition of low soil moisture.

Grasslands have been heavily used throughout millennia of human history. Globally, more people inhabit grasslands than any other biome.[1] They provide many goods and services that are vital to humans: biodiversity, food, forage, livestock, biofuels, carbon storage, provision of drinking water, tourism and recreation, as well as playing other important supportive ecosystem functions.[2] Grasslands are important repositories of biodiversity: they form one-quarter of 142 terrestrial ecoregions identified as priorities for conservation by WWF Global 200 and support nearly half of all endemic birds and one fifth of plant species.[3] Grasslands have been the seedbeds for the ancestors of virtually every major cereal crop and the pre-domestication home of our most important livestock.

A long history of human use and abuse of grasslands has substantially shrunk their area around the world. Nowadays, the Temperate grasslands, savannas and shrublands biome has the least protection globally with mere 2% in strict protected areas.[4] The greatest loss of grasslands is in North America.[5,6] Current estimates indicate that, on average, less than 20% of original grassland habitats in the Central Plains remain, and only 3.5% has been protected overall within Canada.[7,8] Locally, the loss of different grassland types can be even greater, e.g. in Saskatchewan, less than 1% remains of the once vast fescue prairie.[9] In Europe, grasslands are mostly of anthropogenic origin.[10] The exceptions are the areas in alpine regions, along rivers and remnant fragments of steppe vegetation.[11] Vast steppe grasslands that originally extended from south-east to central Europe have been destroyed to a greater degree than any other type of vegetation. The last big “taming of the steppe” occurred about 200 years ago in Ukraine and nowadays about 82% of its steppe area is destroyed.

Most of the American prairies and European steppes were plowed by settlers, due to the extremely fertile soil. This has led to tremendous changes, and most recently, the loss of much of this biome occurred primarily due to agriculture, fragmentation, invasive exotic species, and the lack of a natural dynamic regime. The movement of herds of grazing animals and wildfire activity traditionally held back tree growth and invasive species, but with those factors largely gone, remaining grasslands are slowly reverting to woodland and forest. The main threats currently facing grasslands in Canada are changes in land use and abandonment of traditional activities, afforestation and intensification of grassland management.[12,13]

This short outlook illustrates the importance, multiple functions and threats to temperate grasslands in different parts of the world. The question one could ask is: why people on the Canadian prairies should be interested in the Ukrainian steppes? First, the steppes and the prairies have many biological similarities at the generic and even species level. Second, there are many examples of native plant species from one area that have become invasive weeds in the other. Third, plants from the steppe have become important forage and crop species in the prairie. Fourth, settlers from the Ukrainian steppe regions brought their agricultural expertise, seeds, and culture to the Canadian prairie provinces enriching the agricultural and cultural fabric. Therefore, the purpose of this paper is to describe the current state of the steppes of Ukraine, identify the main threats to them, and highlight the potential for collaboration of Canadian and Ukrainian scientists and practitioners in conserving temperate grasslands.

THE STEPPE ENVIRONMENT

Ecology of the Steppe

Grassland vegetation occurs mainly in lowland areas in the middle latitudes in areas with continental climate, where the summers are warm and dry and the winters are cold. Shortage of rainfall limits the growth of woody plants and prevents the development of a closed forest cover. Natural grasslands of the temperate zone of Eurasia are called the steppes. Russian and Ukrainian were the languages from which the term "steppe" was borrowed (etymology of the word is associated with the space, ground, and plain), first appearing in international botanical terminology in the 18th century.

The Eurasian steppe stretches from an enclave in Hungary, where it called puszta (meaning "bare, empty"), through a chain of small remnants in Romania and Moldova to a vast area of south Ukrainian (Fig. 1) and south Russian plains, north Caucasus, south Ural, and north Kazakhstan to south Siberia, Mongolia and north-east China.[14] Often the Eurasian steppe is divided into three main parts – the Pontic steppe, the Kazakh steppe, and the Mongol steppe. Similar vegetation types can also be found on other continents. In North America, common name for grasslands is the prairies (from French, meaning "a treeless grassy plain"). They form a triangular area from Alberta, Saskatchewan, and Manitoba in Canada through the Great Plains to southern Texas in the USA and down to Mexico.[12]

The Ukrainian steppe (Mariupol station) lies within the temperate continental climate zone and in comparison with the central part of the Eurasian steppe (Semipalatinsk station, Russia) or central part of the Canadian prairie (Saskatoon station), is milder and more moist (Fig. 2). Also, annual precipitation is more evenly distributed through the steppes in Eurasia than the prairies in North America. Overall, distribution and structure of steppe vegetation in Ukraine depends on climate and soil factors, and the main limiting factor of the vegetation is a lack of moisture.[15] The mean annual temperature and total precipitation change from south to north (from 9-10°C to 7-9°C and from 350 mm to 450 mm, respectively).

The Eurasian steppe landscapes are characterized by far horizons and prevalent flat to undulating relief, mostly at low altitudes. A typical soil matrix is loess, which covers varied geological bedrock. The steppe ecosystem gave rise to the world's most fertile soils, chernozems (Russian and Ukrainian for "black soils") named after their characteristic dark-coloured humus horizon. The soils within steppe zone in Ukraine change from light and dark chestnut soils occurring in combination with solonetzic soils, through southern chornozems, to typical humic chernozems. Chernozem soil types also occur in the prairies of North America.

Biodiversity of the Steppe

The steppes of Ukraine are situated in the west part of the Eurasian temperate grassland biome and occupy about 300,000 square kilometers.

The characteristics of the pristine steppes of Ukraine were described in the beginning of the 19th century by Pachoski (1917)[16], Kleopov (1933)[17] and some other authors. Later, steppes became the subject of intense investigations by many Ukrainian and Russian scientists. Bilyk (1973)[18] has summarized data on the steppe vegetation of Ukraine and gave a critical review of previous studies. There are zonal (geographical, ecological) patterns corresponding to the climate and soil patterns of the steppe community's distribution in Ukraine.[15] Overall, vegetation changes towards the south from forest-steppe zone (which

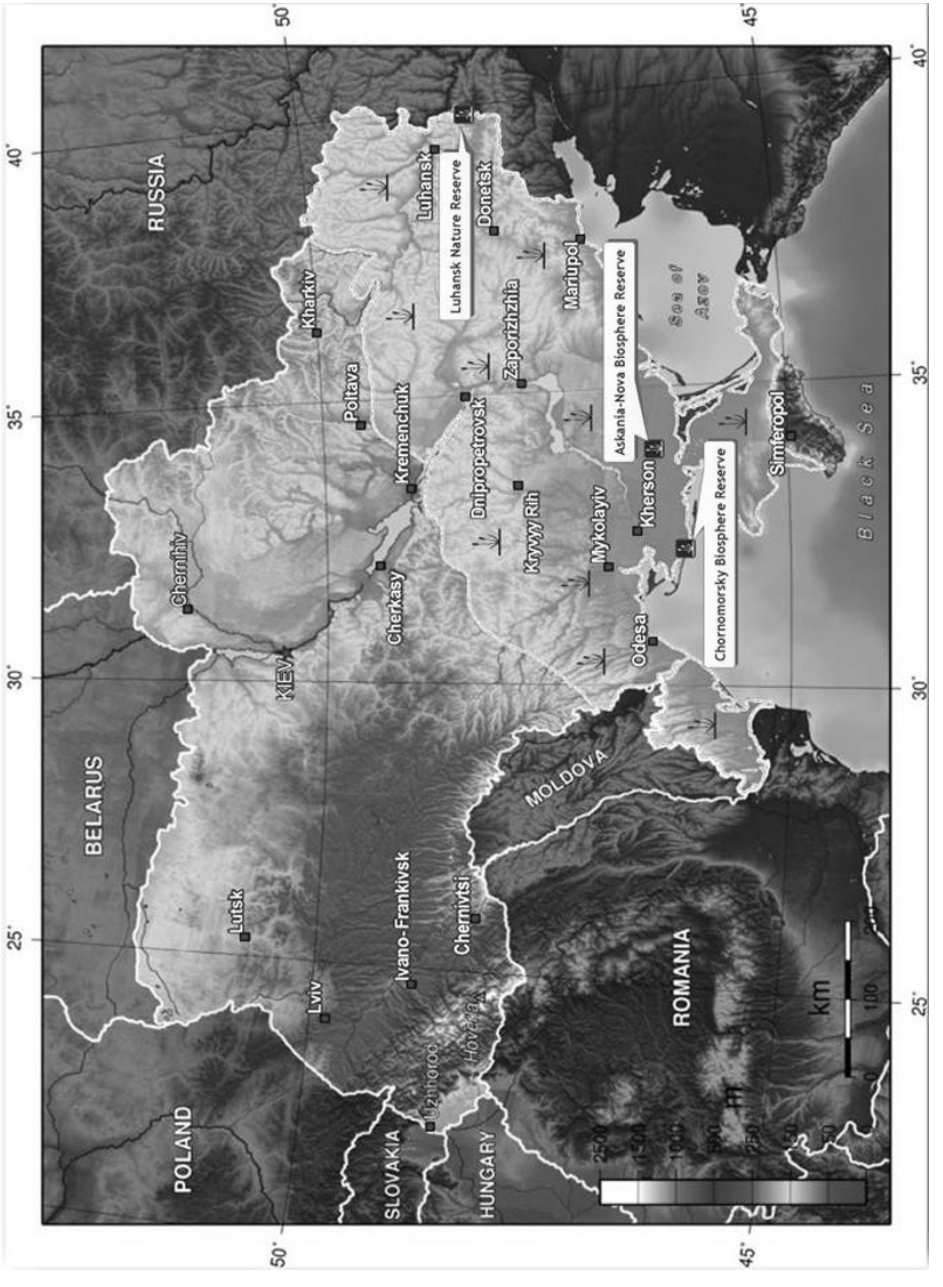


Figure 1. Map of the Ukrainian steppe with locations of the visited reserves [see back inside cover for colour version].

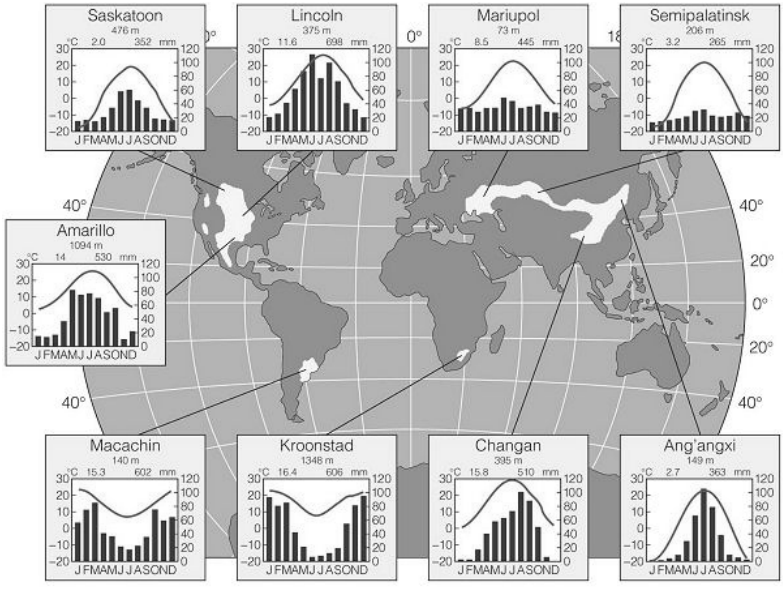


Figure 2. Climate diagrams for temperate grasslands. The diagrams include: name of station, elevation (m above sea level), mean annual temperature (° C), mean annual precipitation (mm), and months; left axis – mean monthly temperature (° C), right axis – mean monthly precipitation (mm).[39]

exist as climatically determined belt between forests and steppes) to steppe zone. Meadow steppes in the northern part of steppe zone gradually change to true steppes in its central and southern parts. Stone steppes are scattered in the south-eastern part of steppe range in the Donetsk Upland while halophytic desert steppes are located along the Azov Sea and the Black Sea. Distribution of both stone and halophytic steppes is caused by soil factors. There are very diverse steppes on the Crimean peninsula as well. Their distribution is driven by an elevation gradient, which is manifested by changes in temperature, precipitation, and soil types.

Meadow steppes can be found as isolated islands completely surrounded by forests in forest-steppe zone or they form dominated vegetation type in the northern part of steppe zone. These grasslands on deep and very fertile chernozems are different from the much drier grasslands in central and particularly southern parts of steppe zone. They have a specific structure and peculiar species. In fact meadow steppes are often called 'hayfield steppes' which illustrates high quality fodder they provide and their general aspect.

Formerly, the majority of the northern Black Sea region was occupied by true steppes or herb-rich grass steppes (forb–rich fescue/feather–grass steppes). Nowadays, grass steppes (forb–poor fescue/feather–grass steppes) prevail. Their vegetation cover consists mainly of turf grasses from such genera as *Stipa, Festuca, Poa, Koeleria* and *Agropyron* as well as sedges (*Carex*). Compared to meadow steppes located to the north and true steppes, grass steppes have fewer forbs and increased participation of ephemeral plant species. This results from a drier climate and different soil types.

Stone steppes occur on poorly developed soils, slopes where erosion rates are particularly high, and often on rock outcrops (granites, limestones, and chalk). Compared to other steppe communities, stone steppes are less productive. However, the share of endemic plants is much higher than in the zonal steppe ecosystem because stone steppes served as refuges for many species during unfavourable climatic epochs. Perhaps vegetation of stone steppes and rock outcrops is not just a special variant of zonal steppe but an ancient floristic complex. Endemics and relics include many species, especially from such taxa as *Astragalus, Oxytropis, Hedysarum, Stipa,* and *Dianthus*.

Halophitic steppes, with a domination of sagebrush (*Artemisia)* species and grasses (*Stipa, Elytrigia,* and *Puccinellia)* occur on the saline soils mainly along the seacoasts and have limited distribution. However, this results from soil factors and is not caused by the climate. Usually they occur in combination with halophytic vegetation (solonetz, solonchak).

The flora of the Black Sea steppe region differs from other European floras in their great originality and richness. Studies of the flora have been conducted by many outstanding researchers (Besser, Ledebour, Pallas, and Shmalgausen just to name a few) and they date as far back as 18th century.[19] The Black Sea steppe represents the western border of the natural range of many plant species growing in the vast steppe zone of Eurasia. There is a significant number of species which were first described from the Black Sea steppe, including many relic and endemic (about 10%) vascular plants. Among 826 vascular plants included in the national list of rare and endangered species – Red Data Book of Ukraine,[20] 276 species (33.4% of the total) occur in the different variants of steppes (including rock outcrops). Many rare and endemic species as well as species on the edge of its range that occur in the region (Fig 3,4) are included in the international list of rare and endangered species – European Red List[21] and IUCN Red List of Threatened Plants.[22]

There are 31 steppe vegetation community types, each of which includes its own plant communities, listed in the Green Data Book of Ukraine.[23] The Green Data Book of Ukraine is a very progressive document because its main focus is not on plant species protection but rather on biodiversity conservation within the entire plant community or habitat. This vision might be achievable only through the establishment of steppe habitat protection. However, the required baseline threatened habitat inventory has not yet been done in Ukraine. This lack of data prevents effective protection of all the most important steppe remnants and optimization of a network of nature protected areas.

Figure 3. Iconic plant species Ukrainian feather-grass (Stipa ucrainica).

Figure 4. Iconic animal species steppe marmot (Marmota bobak)

HUMAN COLONIZATION OF THE STEPPE

The steppes of Ukraine represent a rich cultural legacy spanning almost eight millennia. According to Lillie,[24] the emergence, development and decline of the Trypilian culture in Ukraine represents a significant stage in the history of the steppe zone during the prehistoric period (around 5500-2300 BC). The genesis and expansion of this culture coincides with the Holocene climate optimum when warm and humid climate, fertile soils, and lush grasslands intermingled with patches of broadleaved forests were at an ideal stage of evolution for the expansion of agriculture. It is believed that increasing climate aridity after around 3500-3200 BC caused instability in the Trypilia farming economy, finally leading to stockbreeding and specialized pastoralism. These changes created a base for a diverse range of new cultural groups formed at the transition to the Bronze Age. The culture grouping reflected growing socio-economic, political, and ritual differences among tribes and shaped a new nomadic type of culture in the steppe zone of Ukraine.

Later, in Classical antiquity, the Black Sea steppe corresponds to Scythia and Sarmatia. These steppes were used by numerous nomadic tribes, many of which went on to conquer lands in the settled regions of western and central Europe and in western and southern Asia. Over two thousand stone statues (called "babas") from the Scythian (the 7th century BC) to the Polovets (Kipchak or Kuman) and other cultures of 9-13th centuries (Khazars, Slavs, Tatars, Mongols, etc.) are scattered across the steppe zone. There are also many kurgans, also called barrows or burial mounds, which form a characteristic and unique element of the steppe landscape with specific flora and many threatened plant species.[25]

The Ukrainian steppe formed an important component of the modern nation's psyche. The steppes are closely related to issues of cultural wealth and history, and are reflected in folklore and songs. They are exclusively associated with the free life of the Zaporozhskyi Cossacks. The steppes were an important natural and geographic factor in the development of Ukraine's nomadic stock-raising and agricultural ancestors. The wide open space of the steppes was the place where traditional trades and crafts were established and where cultural traditions and habits evolved.

The final waves of colonization of the steppes, exploiting its rich chernozems, iron ore and coal deposits, happened in the 16th to 18th centuries when they were brought under the control of a sedentary peoples of different ethnic and religious backgrounds: Ukrainians, Russians, Jews, and Germans, as well as Mennonites, Poles, Tatars, Greeks, Bulgarians, and others.[26] Due to the agricultural revolution on the steppes, Ukraine, in a short period of time, became the "breadbasket" of Europe.

Because of political discrimination against ethnic and religious minorities by the Russian Empire institutions during the 19th century, tens of thousands of people left the Ukrainian steppes to open up the Canadian prairie frontier. These immigrants introduced wheat from Ukraine to the New World, and it was used to develop successful varieties of Canadian wheat, such as Marquis.[27] All this heavily contributed to the settlement of the prairies, and sparked an economic boom in Canada. By the middle of 20th century Saskatchewan became the new "breadbasket" – the largest wheat producer in the world. Indeed, steppes and prairies have been a blessing for both Ukraine and Canada. It is our generation's task to rescue them from degradation and save this treasure for the future.

CHALLENGES AND OPPORTUNITIES IN THE STEPPE

The Steppe in Transformation

The steppe occupied more than 40% of Ukraine in the past. Many years ago herds of European wild horse or tarpan (*Equus ferus* Boddaert) and steppe antelope or saiga (*Saiga tatarica* L.) roamed these steppes, golden eagles (*Aquila chrysaetos* L.) hovered in the sky, and great bustards (*Otis tarda* L.) performed their awkward flights. Unfortunately, that time has passed. Total destruction of steppe ecosystem started 150-200 years ago when large-scale colonization began to exploit its natural resources. The high population density and availability of rich chernozems induced a full-scale tilling of the steppe. The last large areas of steppe were plowed during the Soviet Union kolkhoz (collective farm) campaign to expand food production in favour of annual crops. Nowadays, the steppe is almost completely plowed: therefore virgin vegetation occurs almost exclusively on terraces of river valleys, steppe ravines (called "balka" in Ukrainian), steep slopes, and eroded lands. Large areas of steppe also survived as military training grounds. However, even these steppe remnants might disappear because of privatization and under the impact of artificial forest plantation.

Such a significant steppe loss put them at the center of public interest and drew the attention of nature conservationists and scientists. Several natural reserves were established to protect representative variants of steppe vegetation. However, today, only a handful of areas remain where truly natural steppe vegetation is found. Steppe communities occupy less than 3% of the country and steppe protected areas cover only about 1%.

Despite the odds, there is a new ecological opportunity for the steppes after the collapse of Soviet-era kolkhoz (large collective farms) farming. The collapse of socialism resulted in rapid and drastic changes in political, societal and economic structures. This affected land use and the provision of ecosystem services in a profound way. During the last two decades, Ukraine gradually abolished large collective farms and divided up the land among the small landowners. Most productive land was quickly leased by big agribusiness companies. However, large areas of less productive farmland that once were pastures (some of them never were plowed) or overused croplands are now fallow.

Figure 5. Halophytic steppe in Chornomorsky Biosphere Reserve, site Tendrivska Bay (Kherson oblast, Ukraine).

Figure 6. True steppe in Askania-Nova Biosphere Reserve (Kherson oblast, Ukraine).

Figure 7. Stone steppe in Luhansk Nature Reserve, site Provalsky Steppe (Luhansk oblast, Ukraine).

According to Charles[28] there is a growing interest among farmers in Ukraine, particularly in Luhansk province, to bring back the steppes through re-seeding of this abandoned land with native plant species, the introduction of a grazing regime and the raising of high-quality beef cattle. This will also assist in restoring a traditional Ukrainian cattle breed, known as Red Steppe, which survived in Askania-Nova Biosphere Reserve. In my opinion, establishing regional learning centers to encourage farmers and environmental organizations to work together to reverse land degradation might be quite promising. These public and private lands can be managed using livestock as a tool to promote their recovery at low cost. They can sustain abundant wildlife and healthy rural communities once again.

Some of the steppe biosphere reserves and national parks with high tourism potential are prepared to seek mutually beneficial forms of cooperation with the business community. This may involve projects which, on the one hand, make a profit, but on the other, help to restore nature, rather than harm it. State budget funds typically are only sufficient to pay salary to its staff and maintain very limited activities. In such a situation, reserve management is only possible with the involvement of private investment. However, Ukrainian business has not yet realized the benefits of such investments. Therefore, it is still very rare, although a desire of park administrations to cooperate with investors often determines how quickly and successfully a project will be implemented. It should be noted that many directors are concerned about such initiatives and believe that business should not participate in nature conservation projects. In their view, businessmen are primarily interested in leasing land from reserves in order to exploit it unsustainably, which is essentially prohibited by existing law. Transfer of land through different leasing schemes can discredit the nature protection idea and some of the steppe areas even might lose their original function.

The Canadian-Ukrainian Collaboration

To explore the link between biodiversity conservation and sustainability in the Canadian prairies and the Ukrainian steppes, we have initiated research collaborations and field visits in both countries. This initiative was made possible through a grant from International Development Research Centre (IDRC), Canada obtained in 2010-2011. The long-term goal of this program is to examine how human impact on temperate grasslands and climate change can be mitigated through improved professional practice and collaboration in natural resources management.

The main participants in the conservation and sustainability in the Canadian prairies and the Ukrainian steppes project are scientists (Dr. V. Kricsfalusy) and graduate students (A. Henderson) from School of Environment and Sustainability at the University of Saskatchewan and respectively from M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine (Dr. M.V. Shevera) and Luhansk Taras Shevchenko National University (O.V. Kucher).

Project participants have met with their academic partners as well as with representatives of conservation organizations in Canada (Grasslands National Park, Cypress Hill Interprovincial Park, and Redberry Lake Biosphere Reserve) and nature protection institutions in Ukraine (Chornomorsky Biosphere Reserve, Askania-Nova Biosphere Reserve, Luhansk Nature Reserve, and Svyati Hory National Park). Each meeting

brought together conservationists, specialists, and scientists to discuss and identify the common threats and common solutions for conserving temperate grasslands.

During the field visits project participants sampled the variety of dry grassland types in both geographical and ecological terms. We found wonderful grassland communities, rich in plant species, including some endemics. We analyzed flora, vegetation and biodiversity of various grasslands in the selected study areas. We also used available literature and Internet resources to provide scientific background for the characterization of the visited areas.

The effectiveness of such learning exchanges, aimed at building the collaboration to conserve grasslands has recently been shown by Curtin and Western[29] with the example of African and American pastoralists, ranchers, scientists, and conservationists. The authors argue that such interchanges can speed up learning and adaptation by reaching beyond local circumstances and experience.

Apart from the gathering of valuable scientific data, project participants aimed to include a cultural exchange, given the fact that the steppes of Ukraine were the ancestral homeland for several ethnic and religious groups (Ukrainians, Germans, Mennonites, Hutterites, and Doukhobors) who settled on the Canadian prairies in the 19-20th centuries.[30] Also, we believe that this project will help to fill a gap in academic discourse regarding the steppes of Ukraine and break linguistic barriers that have limited access to this topic for most Western researchers.

CONSERVATION OF THE STEPPE

The Steppe Reserves

The joint field visits of the international research group were conducted in the province of Saskatchewan, Canada and in Kherson, Luhansk, and Donetsk oblasts (regions) of Ukraine during July 26-August 5, 2010. Here we characterize only the visited locations in the south-eastern Ukraine (Fig. 1).

Chornomorsky Biosphere Reserve.

The biosphere reserve ("Chornomorsky" is "the Black Sea" in Ukrainian) is situated on the northern coast of the Black Sea on the territory of Kherson oblast (small part of its area extends to Mykolaiv oblast). The reserve was established in 1927 and became the biosphere reserve in 1984. Its area totals 89,129 ha, with 70,509 ha of core zone. The terrestrial part of the biosphere reserve includes only 14,148 ha. The relief is very flat, and the altitude is 0-8 m above sea level (a.s.l.). Sand arenas are a mosaic of 3-5 m tall hillocks alternated with numerous depressions along the sea coast. Sands are underlined with limestone.

The biosphere reserve represents shallow water sea bays, wetlands and temperate grasslands. Within the terrestrial habitats major interest represents forest-steppe on alluvial sands with oak (*Quercus robur*), birch (*Betula borysthenica*), and plum (*Prunus stepposa).* Unique seaside halophyte bunch-grass steppe occurs only in two sites – Potiyivska (1064 ha) and Yagorlytskyi Koot (840 ha). Here steppe vegetation stretches up to coastal saline meadows that are moist but rarely flooded. These habitats support fescue (*Festuca valesiaca)*, alkali-grass (*Puccinellia fominii)*, and couch-grass (*Elytrigia pseudocaesia)* communities. The flora of the biosphere reserve includes over 700 species of vascular plants (including 60 endemics), 24 of which are listed in the Red Data Book of Ukraine[20], 17 in the European Red List[21] and 7 in the IUCN Red List.[22]

The fauna of the biosphere reserve includes 452 species, among them 86 species of fish. Sixty-nine fauna species are listed in the Red Data Book of Ukraine,[20] and 12 in the IUCN Red List.[22] The aviafauna of the area is particularly rich and totals 306 bird species (of which 110 are nesting here), including over 20 rare and endangered species listed in the Red Data Book of Ukraine.[20] Among them are white-tailed eagle (*Haliaeetus albicilla*), demoiselle crane (*Anthropoides virgo*), great white pelican (*Pelecanus onocrotalus),* little bustard (*Tetrax tetrax),* etc. The biosphere reserve is also important place for many migratory birds. The reptiles are represented by rare Renard's meadow viper *(Vipera ursinii renardii)* and four-lined snake (*Elaphe quatuorlineata*).

Site 1: Chornomorsky Biosphere Reserve (core zone), 1 km west of the town of Zalizny Port (Fig. 5). The altitude is 0 m a.s.l., 46^{0}08'07.82" N, 32^{0}14'02.67" E. The site lies in close proximity to Tendrivska Bay of the Black Sea. The terrain is very flat, with small potholes sometimes filled with water that comes from the bay during heavy sea storms. Species richness value is high, and we registered 32 vascular plant species at 100 m^2 plot. Vegetation of the site is represented by halophytic steppe community dominated by fescue (*Festuca valesiaca)* and feather-grass (*Stipa capillata*). Total vegetation cover is 60%. The most common species of the upper canopy are feather-grass (*S. lessingiana*, *S. ucrainica),* brome-grass (*Bromus riparius*), hedgenettle *(Stachys recta),* couch-grass (*E. pseudocaesia),* etc. In the lower canopy occur fescue (*F. pallens),* crested wheat-grass (*Agropyron pectinatum*), June-grass (*Koeleria cristata*), santonica *(Artemisia cina),* knapweed *(Centauria breviceps),* Regel's onion *(Allium regelianum),* pasqueflower (*Pulsatilla pratensis*) and other forbs.

Askania-Nova Biosphere Reserve.

The biosphere reserve is situated south-east of the town Kakhovka in southern part of Kherson oblast. The natural reserve was established here in 1888 by Baron F. Falz-Fein of German ancestry who dedicated part of his estate to nature conservation, making this area the biggest preserved steppe in Europe. In 1993 it received the status of the biosphere reserve, with dendrological and zoological parks. Total area is 33,308 ha (core zone 11,054 ha), altitude 18-30 m a.s.l. Dominant types of soils within the area are chernozems and dark brown soils, gley soils rarely occur in terrain depressions.

The major habitats are zonal steppe and bushy steppe communities dominated mainly by different species of feather-grass (*S. lessingiana, S. ucrainica,* etc.*)*, intermingled with fescue (*F. valesiaca*) and June-grass (*K. cristata*) in some place. The flora of the biosphere reserve includes 515 species of vascular plants, 20 of which are listed in the Red Data Book of Ukraine[20] and 6 are included into the IUCN Red List.[22] There are also 53 endemic plant species, 7 of which are local endemics and occur only on the territory of the biosphere reserve.

The animal world of the biosphere reserve is typical for steppe landscapes. It is inhabited by 29 mammal species, 9 species of amphibians and reptiles, 8 fish species, and 272 species of birds. Overall, 73 species of vertebrates and invertebrates are listed in the Red Data Book of Ukraine.[20] Among common animals are little ground squirrel or souslik (*Spermophilus pygmaeus*), steppe marmot or bobak (*Marmota bobak*), great jerboa (*Allactaga major*), steppe polecat (*Mustela eversmanii*), red fox (*Vulpes vulpes*), etc. Herds of wild hoofed animals from different continents are held here all year round under near-

natural conditions: American bison (*Bison bison*), steppe antylope or saiga (*Saiga tatarica*), Przhevalski's horse (*Equus ferus przewalskii)*, Turkmenian wild ass or kulan (Equus hemionus kulan), etc. In summer, common eland (*Taurotragus oryx*), wildebeest or gnu (*Connochaetes gnou)*, blue antelope (*Hippotragus leucophaeus*) which are extinct in the wild, common zebra (*Equus quagga)* and other animals join them.

Site 2: Askania-Nova Biosphere Reserve (core zone), 1,5 km east of the town of Askania-Nova (Fig. 6). Altitude 28 m a.s.l., 46°27'21.74"N, 33°54'2.37"E. Vegetation of the site is represented by true steppe community dominated primarily by different species of feather-grass (*S. ucrainica,* with subdominance of *S. lessingiana* and *S. capillata).* This is a typical plain steppe ("plakorny" in Ukrainian) which occupies flat areas with uniform ecological conditions and well developed soil cover. This might explain lower species richness (23 per 100 m^2) of this site compare to the halophytic steppe (Site 1) or stone steppe (Site 3). Total canopy cover is about 65%. Upper canopy is formed by turf grasses (*Stipa* spp.) and some species of forbs: thistle *(Carduus uncinatus),* alfalfa *(Medicago romanica),* eryngo *(Eryngium campestre),* bedstraw *(Galium ruthenicum),* toadflax *(Linaria macroura),* and statice *(Goniolimon tataricum).* In the lower canopy were registered fescue (*F. valesiaca),* June grass (*K. cristata*), wormwood *(Artemisia austriaca),* milk-vetch *(Astragalus henningii),* and other forbs. A well-developed group of ephemeroid plants is present in this community during the spring season. It is formed by such plant species as yellow star-of-Bethlehem *(Gagea bulbifera),* tulip *(Tulipa schrenkii),* iris *(Iris pumila),* etc. There is a moss and lichen layer as well.

Luhansk Nature Reserve, Provalsky Steppe massif.

Provalsky Steppe is one of three separated massifs of Luhansk Nature Reserve to which it was included in 1975. Provalsky Steppe is situated south-east of the town Sverdlovsk near village Provallya in Luhansk oblast on the border with Rostov oblast of Russia. Total area of the nature reserve is 587,5 ha. It lies within Donetsk Upland, the most eastern part of the highest mountain range of the region. The relief is very hilly, altitude 150-230 m a.s.l. The terrain is divided by deep ravines and valleys. Sandstone, limestone and sandy shale are key components in the geological composition of the area. Prevailing soils are gravelly chernozems, loams and silt loams.

The nature reserve represents the unbroken stony steppe dominated by sheep's grass (*Festuca ovina*) and different species of feather-grass (*S. capillata, S. ucrainica, S. dasyphylla*, etc.), which is rare for Ukraine. Specific petrophytous-steppe communities, where calciphilous species dominate, have been established in the nature reserve on the poorly developed and eroded stony soils on outcrops of limestone along Donetsk Upland and in some places on ravine slopes. Oak woodlands *(Q. robur)* with different species of maple (*Acer tatarica, A. campestre*), apple (*Malus sylvestris*) and pear (*Pyrus communis*) are scattered in ravines and flood plains of Provallya river. Flora of the nature reserve is very rich and includes 792 vascular plants, among them 135 endemic species. Twenty-nine vascular plants (among them 11 species of feather-grass) listed in the Red Data Book of Ukraine,[20] and 7 species are included into the IUCN Red List.[22]

The animal world of the nature reserve is characterized by presence of steppe, forest and semi-desert species. The list

of fauna species includes 47 mammals, 174 birds, 9 reptiles, and 6 amphibians. Sixty-eight species are included into the Red Data Book of Ukraine[20] and 22 are listed by the IUCN Red List.[22] Among rare mammals occur Southern birch mouse (*Sicista subtilis*), great jerboa (*A. major*), steppe polecat (*Mustela eversmanii*), marbled polecat (*Vormela peregusna)* and others. Rare reptiles are represented by Renard's meadow viper *(V. ursinii renardii),* Caspian whipsnake (*Dolichophis caspius),* and four-lined snake (*E. quatuorlineata*).

Site 3: Luhansk Nature Reserve, Provalsky Steppe massif (Site Pivnichny, core zone). Seven km east of the village Provallya (Fig. 7). Altitude 173 m a.s.l., 48° 8'45.89"N, 39°53'25.77"E. The forb-fescue-needle grass community occupies the middle and lower part of north facing slope on chornozems. Species richness value is very high, totalling 41 vascular plants in a 100 m^2 plot. Total vegetation cover is about 65%. It has three-layer structure, with heights 40-60 cm. The studied vegetation community was mostly dominated by feather-grass (*S. pennata*) and forbs. Graminoids were represented by fescue (*F. valesiaca, F. pallens*), feather-grass (*S. capillata*), June-grass (*K. cristata*), meadow-grass (*Poa versicolor*), and sedge (*Carex humilis*). The stand was very rich in perennial forbs, with species such as speedwell *(Veronica incana),* dianthus *(Dianthus andrzejowskianus),* wormwood *(Artemisia marschalliana),* dropwort *(Filipendula vulgaris),* medow-rue *(Thalictrum minus),* eryngo *(Eryngium campestre),* sandwort *(Arenaria biebersteinii),* cinquefoil *(Potentilla arenaria),* inula *(Inula aspera),* yarrow *(Achillea millefolium),* mullein *(Verbascum vernum),* clover *(Trifolium alpestre),* trina *(Trina kitaibelii),* forget-me-not *(Myosotis popovii)* and many others. The ground layer is formed by different species of mosses and lichens.

Long-Range Forecast

Whether the remnants of the steppe, even if under protection, are capable of stable existence and recovery remains questionable. The ecological structure and function of the steppe ecosystem is damaged and its area is so small that the native vegetation can no longer successfully spread into nearby abandoned fields. Also, intensive human uses of the previously native steppes and now agricultural landscape modification brought invasive alien plants. Most of them are noxious weeds that may prevent natural recovery of steppe ecosystems on abandoned agricultural lands or slow this process for decades. We observed a growing trend of transcontinental exchange with invasive plants between Ukraine and Canada.[31,32] There are several plant species native to Canada, e.g. Canadian horseweed [*Conyza canadensis* (L.) Cronquist] and Canada goldenrod (*Solidago canadensis* L.) currently threatening the steppe ecosystems of Ukraine and vice versa – some species from the latter region, for example, dog-strangling vine [*Cynanchum rossicum* (Kleopov) Barbarich], become severe invaders in Canada. Only recently have researchers started to analyze problem of shared invaders, possible relationships between invasive alien plant distribution, species traits and habitats in native ranges and by new invaded regions.[33]

The disappearance of permanent components of steppe biota which are extremely important for its existence – ungulates and burrowing animals – led to the destabilization of steppe ecosystem.[34,35] Despite that, some forms of human activity which simulated natural impact were able to stabilize the steppe ecosystem. That is why establishment of nature reserves to protect steppe remnants only made things worse. Xerophyte turf grasses are forced out by

mesophyte rhizomatous herbs. Provision of a mowing regime alone cannot halt this type of succession, even if it inhibits invasion by woody plants.[36] Liberated from the impact of stabilizing factors of human activity, the steppe ecosystem is quickly being transformed into shrub-tree complexes. In many places trees and shrubs are spreading fast, as some of them are very aggressive, e.g. Russian peashrub [*Caragana frutex* (L.) K. Koch] and buckthorn (*Rhamnus cathartica* L.). In addition to this, foresters "contributed" to the problem of afforestation by converting remnants of steppes through planting trees.

Nowadays, because of afforestation and climate change, steppe ecosystem degradation is greatly accelerated. According to recent studies,[15] special programs aimed to conserve the biodiversity of the Ukrainian steppe should be implemented and expanded. Unfortunately, all nature reserves visited during this trip are currently underfunded and hardly able to maintain their infrastructure, let alone support research projects. Fortunately, a traditional monitoring program with strong long-term components is still carried out.

Throughout all visited protected areas concerns were expressed over land encroachment, conflict with wildlife, weak governance, and growing population poverty. The consensus reached by scientists and conservationists was that reducing the downward spiral of environmental degradation and biodiversity loss can be achieved through raising public awareness, increasing local community participation, enhancing sharing of knowledge, and ensuring international partnerships. The replacement of confrontation with collaboration between antagonistic groups such as private land owners and conservationists is a high priority.

There is also a slow paradigm shift from traditional balanced nature protection to dynamic nature conservation among scientists and practitioners, which is a significant barrier for introducing modern management in steppe conservation. To conserve steppe reserves, policies of absolute non-intervention should be abandoned. Managerial practices on steppe lands (grazing, burning, etc.) should be implemented to slow down succession and conserve biodiversity of the ecosystems.

Without any doubt the Ukrainian steppe should be at least locally restored and better protected. It must be ensured that economic growth and resource development take place in an environmentally sensitive manner and that decisions taken reflect the interests of current and future generations. These decisions should enable integration of biodiversity concerns into agricultural policy and further strengthened measures for farmland and biodiversity. This would be also consistent with the Pan-European Biological and Landscape Diversity Strategy (1996)[37] and the European Landscape Convention (2000).[38] The European Commission does recognize multiple functions and values of grasslands and developed different tools to protect them.

CONCLUSIONS

The main threats currently facing the Ukrainian steppes are similar to the problems experienced by the Canadian prairies – including changes in land use, abandonment of traditional activities, loss of large-scale dynamic processes, and climate change. Additional threats to steppes in Ukraine are land privatization, afforestation, insufficient management practices in protected areas, and growing poverty of the rural population. Issues such as habitat loss and fragmentation, native species decline and exotic species

invasion, and management use of grazing and fire are of common concern in both countries.

Given the complexity of threats to the Ukrainian steppe, more detailed studies would be a high priority in order to understand the causes underlying their biodiversity patterns. The steppe plant species and communities represent an outstanding and highly valuable part of world's natural heritage that needs more efficient conservation efforts, particularly as many of the stands are threatened by land use and other changes. Considering the growing global demand for bioenergy, carbon sequestration, food, and the importance of biodiversity conservation it is clear that the steppes of Ukraine should be one of focal regions of the world in this context.

Field visits and other activities have the potential to be substantially enhanced in the areas of research translation and learning exchanges between Canadian and Ukrainian partners. This might be achieved through joint research projects of mutual interest, collaboration between scientists, conservationists and local communities in both countries to improve the management of natural resources. These activities can help build not only ecological resilience of steppe ecosystems, but also increase overall human well-being in rural areas. If carefully managed and planned, sustainable development and biodiversity can go hand in hand and reinforce each other.

This project was conducted with financial support from the International Development Research Centre (IDRC), Canada. Additional support was provided by the School of Environment and Sustainability, University of Saskatchewan.

I would like to thank Prof. S.L. Mosyakin, M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine and Dr. V.A. Kostiushyn, I.I. Schmalhausen Institute of Zoology, National Academy of Sciences of Ukraine, for fruitful discussions and their insights about the steppes of Ukraine. Project participants are very grateful to the staff and institutions that assisted with the field studies in Ukraine: Dr. Z.V. Seliunina and Dr. O.Yu. Umanets (Chornomorsky Biosphere Reserve), Dr. V.V. Shapoval (Askania-Nova Biosphere Reserve), and A.V. Bondarenko (Luhansk Nature Reserve).

I thank Dr. J. Schmutz (University of Saskatchewan) and G. Miller (Toronto and Region Conservation Authority) for their comments on the early draft of this paper as well as Meng Li and Sharla Daviduik for technical assistance in preparing this paper.

1. White R, Murray A and Rohweder M (2000) *Plot analysis of global ecosystems: grassland management.* World Resources Institute, Washington, DC.

2. Gibson D (2009) *Grasses and grassland ecology.* Oxford University Press, University of Oxford, UK.

3. Olson D and Dinerstein E (2002) The global 200: priority ecoregions for global conservation. *Annals of the Missouri Botanical Garden* 89:199-224.

4. Hoekstra JM, Boucher TM, Ricketts TH, Roberts C (2005) Confronting a biome crisis: global disparities of habitat loss and protection. *Ecological Letters* 8:23–29.

5. Samson F and Knopf F (1994) Prairie conservation in North America. *BioScience* 44:418-421.

6. Riley JL, Green SE, and Brodribb KE (2007) *A conservation blueprint for Canada's Prairies and Parkland.* Nature Conservancy of Canada. Toronto, Ontario.

7. Gauthier D and Wiken EB (2003) Monitoring the conservation of grassland habitats, Prairie ecozone, Canada. *Environmental Monitoring and Assessment* 88:343-364.

8. Forrest SC, Strand H, Haskins WH, Freese C, Proctor J, and Dinerstein E (2004) *Ocean of grass: a conservation assessment for the Northern Great Plains.* Northern Plains Conservation Network and Northern Great Plains Ecoregion. WWF-US, Bozeman, MT.

9. Hammermeister AM, Gauthier D, and McGovern K (2001) *Saskatchewan native prairie: statistic of vanishing ecosystem and dwindling resource*. Native Plant Society of Saskatchewan, Saskatoon, SK.

10. Silva JP, Toland J, Jones W, Eldridge J, Thorpe ED, and O'Hara E (2008) *LIFE and europe's grasslands: restoring a forgotten habitat.* European Commission, Luxembourg.

11. Veen P, Jefferson R, Smidt J, and Styraaten J, eds. (2010) *Grasslands in Europe of high nature value.* KNNV Publishing, Zeist, NL.

12. Wiken EB, Gauthier DA, Schrag AM, Hoth J, Aguirre C, and Lafón A (2008) *Temperate Grassland Region: North America. Compendium of regional templates on the status of temperate grasslands conservation and protection.* Temperate Grasslands Conservation Initiative, Vancouver, BC.

13. Atkinson K (2009) Shared visions, shared wildernesses: wilderness conservation in the grasslands of Southern Saskatchewan. *British Journal of Canadian Studies*, 22.1, p. 87-114.

14. Lavrenko EM and Karamysheva ZV (1993) Steppes of the former Soviet Union and Mongolia. In *Natural Grasslands. Eastern Hemisphere and Résumé,* ed. R.T. Coupland, 3-59. Elsevier, Amsterdam.

15. Didukh YP, Tkachenko VS, Plyuta PH, Korotchenko IA, and Fitsailo TV (1998) *Phytodiversity comparative estimate of preserved steppe ecosystems in Ukraine for optimization of conservation regimes.* M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Kyiv, UA.

16. Pachoski IK (1917) *Description of the vegetation in the Kherson region.* Vol. 2 *Steppes.* Estestvenno-istoricheskiy Musey Khersonskoho Gubernskogo Zemstva, Kherson, UA.

17. Kleopov YD (1933) The vegetation cover of the south-western part of Donetsk Kryazh. *Visnyk Kyivskoho Botanichnoho Sadu* 15:9-162.

18. Bilyk GI (1973) Meadow steppe. Typical (true) steppe. Herb–bunch-grass steppe. Desert steppe. Shrub steppe. Semi-savanna steppe. In *Steppes, Screes, and Sands*, ed. A.I. Barbarich, pp. 33-94, 94-170, 229-240, 245-249. Naukova Dumka, Kyiv, UA.

19. Moisienko I, Górski P, and Boiko P (2002) Contributions to the flora of steppes. *Roczniki Akademii Rolniczej w Poznaniu 347, Bot.* 5:123-134.

20. *Red Data Book of Ukraine. Vegetable Kingdom* (2009) Globalconsulting, Kyiv, UA.

21. *European Red List* (2010) http://ec.europa.eu/environment/nature/conservation/species/redlist/index_en.htm (accessed January 17, 2012).

22. International Union for Conservation of Nature (IUCN) (2010) IUCN Red list of threatened species. Version 2010.4. http://www.iucnredlist.org (accessed January 17, 2011).

23. *Green Data Book of Ukraine. Rare, threatened and typical plant communities that need protection* (2009) Alterpress, Kyiv, UA.

24. Lillie M (2008) The Trypilian culture in context. In *Mysteries of ancient Ukraine. The remarkable Trypilian culture 5400-2700 BC*, ed. K. Ciuk, 11-16. Royal Ontario Museum, Toronto, ON.

25. Sudnik-Wójcikowska B, Moysiyenko II, Zachwatowicz M, and Jabłońska E (2011) The value and need for protection of kurgan flora in the anthropogenic landscape of steppe zone in Ukraine. *Plant Biosystems*, 145: 638-653.

26. Magocsi PR (2007) *Ukraine: an illustrated history.* University of Toronto Press, Toronto–London, ON.

27. Symko S (1999) *From a single seed. tracing the Marquis wheat success story in Canada to its roots in Ukraine.* Agriculture and Agri-Food Canada, Ottawa, ON.

28. Charles D (2010) Renewing the post-Soviet steppe. *Science* 328:1225.

29. Curtin C, and Western D (2007) Grasslands, people, and conservation: over-the-horizon learning exchanges between African and American pastoralists. *Conservation Biology* 22:870-877.

30. Barry B (2001) *Ukrainian people places.* Centax Books, Regina, SK.

31. Kricsfalusy V, and Miller G. (2008) Invasion and distribution of *Cynanchum rossicum* (Asclepiadaceae) in the Toronto region, Canada, with remarks on its taxonomy. *Thaiszia Journal of Botany* 18:21-36.

32. Kricsfalusy VV, and Miller G (2010) Community ecology and invasion of natural vegetation by *Cynanchum rossicum* (Asclepiadaceae) in the Toronto region, Canada. *Thaiszia Journal of Botany* 20:53-70.

33. Hejda M, Pyšek P, Pergl J, Sádlo J, Chytrý M, and Jarošík V (2009) Invasion success of alien plants: do habitat affinities in the native distribution range matter? *Global Ecology and Biogeography* 18:372-382.

34. Osychnyuk VV (1973) Succession of the vegetation in steppe. In *Steppes, Screes, and Sands,* ed. A. I. Barbarich, 249-315, 373-398. Naukova Dumka, Kyiv, UA.

35. Tkachenko VS and Chupryna TT (1993) Changes in Striltsivskyi Steppe vegetation cover based on phytocoenological monitoring. *Ukrayinsky Botanichny Zhurnal* 52:252-259.

36. Tkachenko VS, Lysenko GM, and Vakal AP (1993) Changes in Mikhailivska Tzilina Reserve steppe vegetation based on 1991large scale mapping. *Ukrayinsky Botanichny Zhurnal* 50:5-15.

37. Pan-European Biological and Landscape Diversity Strategy (1996) Council of Europes, Strasburg, France.

38. *European Landscape Convention*. (2000) Council of Europe. Florence, Italy.

39. Temperate grasslands. (accessed January 17, 2011). http://www.all-creatures.org/hope/gw/biome_map_temp_grasslands.jpg

Photo - Monarch Caterpillar - Lois Vanthuyne, EC-CWS Last Mountain Lake NWA

INSECTS

AN UNPARALLELED INFLUX OF MONARCHS

Phillip S. Taylor, Saskatoon, SK Tel: 306 665-6371

In 2012, a record number of Monarch butterflies (*Danaus plexippus*) arrived in prairie Canada beginning in late May spreading northwest through Manitoba, Saskatchewan and into Alberta where they are normally rare.[1] A new citizen science web site *eButterfly.ca*, dedicated to monitoring changes in Canadian butterfly populations, states this flight is unprecedented in 140 years. After wintering in the central Mexican highlands adults break their hibernation and begin to migrate north in mid-March, most stopping in the southern United States when they encounter milkweed plants sought for laying their eggs. The Monarch's reproductive cycle is short, as little as 4 to 7 weeks depending on the local environment: egg (7-10 days), caterpillar (14-21 days), pupa (7-21 days), then emerging as fresh adults (http://www.naturenorth.com/summer/monarch/monarchF2.html).[2] This summer generation of Monarchs continues north as conditions allow. Cool weather slows development. Thousands arrive in eastern Canada each spring, accompanied by a few over wintering adults (up to 10%) and later in the summer by more second generation summer adults.[2]

The first Monarchs arriving in Saskatchewan this spring flew strongly and were bright in colour showing little wear. Brenda Kramarchuk reported the first Monarch, at Last Mountain Bird Observatory, on 25 May and except for the days of howling winds, staff at Last Mountain Lake National Wildlife Area saw 1 or 2 most days after that (R. Dickson, pers comm.). Craig Salisbury saw his first Monarch in his Saskatoon garden

on May 26, two to three weeks earlier than normal; and he stated that females began to lay large numbers of eggs on host milkweed plants in his yard almost immediately upon arrival (C. Salisbury, pers comm.). By the first week of June Monarchs were seen in many locations north and west of Saskatoon with numbers peaking a week later near Redberry Lake Biosphere Reserve. During the second and third weeks of June butterflies were seen with increasing frequency near Edmonton (http://www.cbc.ca/news/technology/story/2012/06/20/monarch-butterfly-migration-alberta.html). On July 9, I counted 65 Monarch caterpillars on 176 milkweed plants in a native plant garden in Saskatoon. The plants were between 10 and 80 cm in height and approximately half were in flower. These late instar caterpillars ranged in length from just under 20mm (9) to just over 50mm (24); the latter were approaching their maximum size, before pupating. The following three mornings between 0930 and 1030 hr, I watched adult females, with very drab and frayed wings, lay pale green eggs on the upper and lower leaf surfaces of Showy Milkweed (*Asclepias speciosa*). By 15 July most of the caterpillars could not be found and many of the plants were stripped of their leaves. Monarchs unerringly find isolated milkweed plants in meadows, open areas and urban gardens, even within in the aspen and southern boreal transition forest regions of the Prairie Provinces.[3,4] Five species of native milkweed grow in Saskatchewan.[5] However, when their preferred milkweeds are not available, caterpillars are occasionally found on Dogbane (*Apocynum* sp). I observed one worn female lay single eggs on nearby Sow Thistle (*Sonchus* sp) and Red Osier Dogwood (*Cornus stolonifera*) leaves on 12 July.

There have been other big years for Monarch butterflies in Saskatchewan. Bernie and Mike Gollop describe 1997 as the "year of the Monarch" when butterflies appeared first on 5 June at Waskesiu and were seen through out the southern part of the province until 9 September near Roche Perce.[4] In 2007 impressive numbers were seen from Calgary, Alberta eastward. Juhachi Asai, Saskatoon, states, "In 2007, four chrysalises were given to me on September 13 and I kept them in the Monarch cage until the adults emerged. The adults came out on September 16, 17 and 18. We tagged them and they were released." (J. Asai pers comm.). The last Monarch recorded for Saskatchewan in 2007 was on 2 October in Saskatoon.[6]

Some fall generation adults have been recorded flying in mid October in Manitoba but most leave our region in September.[7] These fall Monarchs delay breeding and will live 8 to 9 months enabling them to make their way back to Mexico for the winter, a trip of up to 4000 km; the next spring they then begin their migration north. Amazingly they complete these migrations without previous experience. A Canadian zoologist, Fred Urquhart, pioneered wing tagging of Monarchs to unravel their mysterious movements which eventually lead to the discovery of their wintering areas west of Mexico City in 1975 (http://www.monarchwatch.org/news/urquhart.htm). In 2010 a *Monarch Butterfly Biosphere Reserve* was established to protect 56,000 ha of this critical pine-oak forest. (http://en.wikipedia.org/wiki/Monarch_Butterfly_Biosphere_Reserve)

You can contribute your Monarch sightings including numbers, locations and dates of caterpillars and adults, to *eButterfly.ca*, thereby helping to document this extraordinary 2012 event which to date has seen steady numbers of butterflies appear for an extended number of weeks.

1. Bird CD, Hilchie GJ, Kondla NG, Pike EM and Sperling FAH (1995) Alberta Butterflies. The Provincial Museum of Alberta, Edmonton. 349pp.

2. Salisbury, Lorriene and Craig (2000) A Monarch diary. *Blue Jay*: 58(2):95-98.

3. Klassen P, Westwood AR, Preston WB, and McKillop WB (1989) The Butterflies of Manitoba. Manitoba Museum of Man and Nature, Winnipeg. 290 pp.

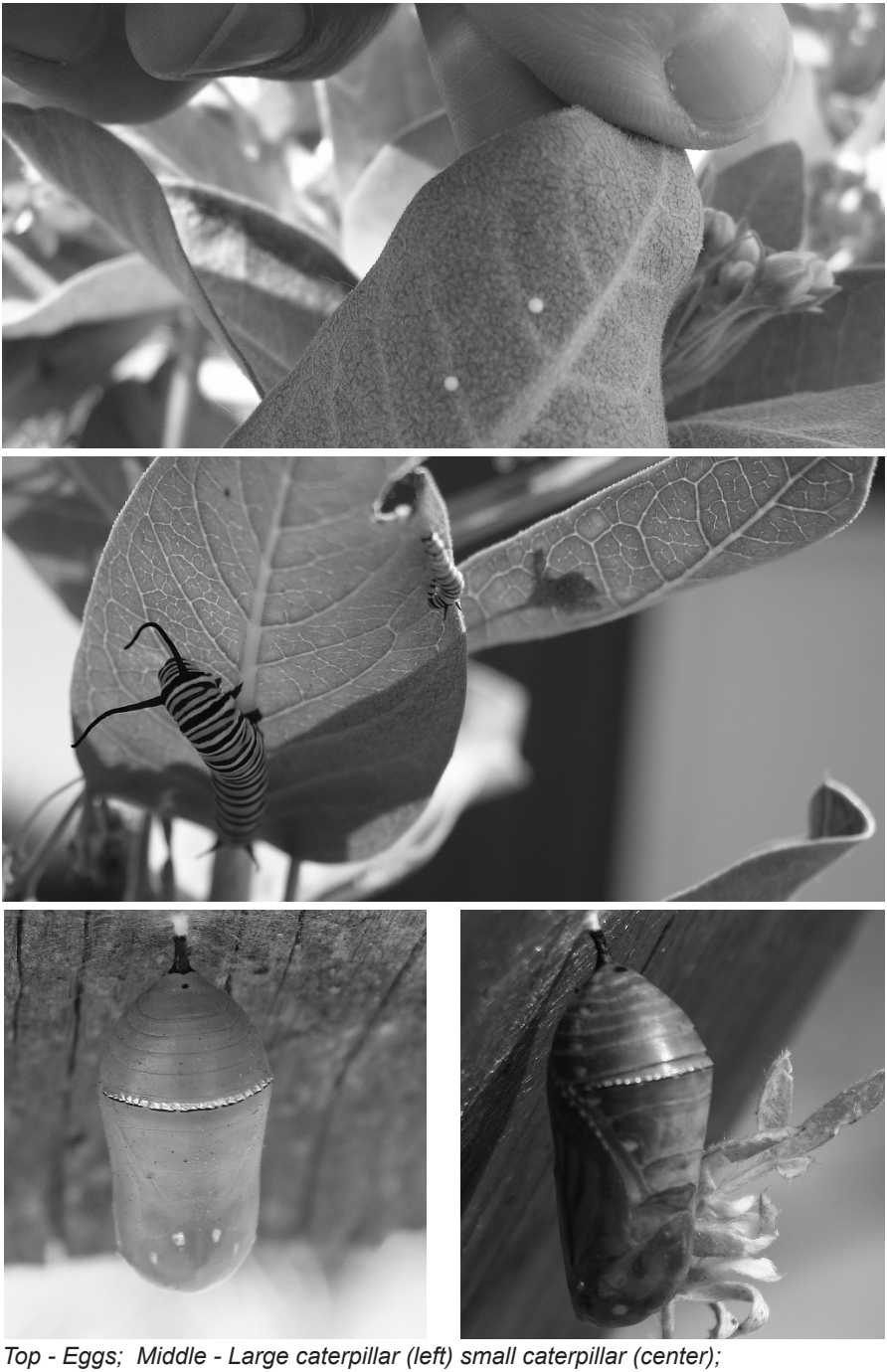
4. Gollop B and Gollop M (1998) 1997 – year of the Monarch in Saskatchewan. *Blue Jay*: 56(1):55-62.

5. Leighton A (1998) Milkweed: the Monarch's prairie host. *Blue Jay* 58(1):46-54.

6. Brooks S (2008) Monarchs in my milkweed. *Blue Jay* 66(3):175-176.

7. Hooper RR (1973) The Butterflies of Saskatchewan. Saskatchewan Department of Natural Resources, Regina. 216 pp.

Tagged adult *-Juhachi Asai*



Top - Eggs; Middle - Large caterpillar (left) small caterpillar (center);
Bottom Left - chrysalis early stages; Bottom Right chrysalis late stages
photos - Lois Vanthuyne, EC-CWS Last Mountain Lake NWA

Top - new adult and empty chrysalis -Lois Vanthuyne, EC-CWS Last Mountain Lake NWA; Bottom - worn adult -Juhachi Asai

NATURE NOTES AND LETTERS

Monarch Caterpillars at Turtleford

Brent Keen Email: brent.keen6@gmail.com

On June 25, I found two monarch butterfly caterpillars feeding on what I believe are dwarf milkweed plants. I have attached photographs of the caterpillars and plants. I live in Turtleford, and have never seen monarchs here before. I was interested to find monarchs breeding this far north and thought you might be interested as well.

Top - Caterpillar on milkweed. *Photos - Brent Keen*
Bottom - Milkweed plants.

MYSTERY PHOTO

June 2012 MYSTERY PHOTO

-Richard Staniforth

The specimen has been sectioned (cut in half from top to bottom) to show the internal details. Do you have any idea what it might be?

Hint: this particular species is widespread in lakes in the boreal region of Canada, including Alberta, Saskatchewan, and Manitoba.

Send your answers to:
bluejay@naturesask.ca

NEW Starting in 2012, correct answers to the Mystery photo will be entered into a draw for cool stuff from Nature Saskatchewan.

For the March 2012 Mystery photo, the lucky NS member is Lauren Mang, who will receive a Nature Sask sling bag. Thanks to all who sent in answers for the mystery photo.

Old Baltimore Oriole nest *Lowell Strauss*

March 2012 Mystery Photo:

We had a number of correct answers for this mystery photo. Dr. Spencer Sealy (Professor Emeritus, Department of Biological Sciences, University of Manitoba) contributed some interesting details:

> " This certainly looks like a last year's nest of a Baltimore oriole that finally dropped out of the tree, on to the grass. In our studies of Baltimore Orioles at Delta Marsh, MB, it was not uncommon to record old nests that had survived the cold and strong winds of fall and winter, only to drop out of the tree in the spring.
>
> One possibility to account for the spring drop of the nests is, although we never actually observed it, is that we have observed Baltimore Orioles and other songbirds approaching last year's nests and tugging nest material from them for use in this year's nest. Some nests were almost dismantled and then fell, hence, this is a possibility. However, the nest in the photograph looks to be essentially completely intact, so it may have been that the newly dried branch that supported the nest simply broke."

Blue Jay, founded in 1942 by Isabel M. Priestly, is a journal of natural history and conservation for Saskatchewan and adjacent regions. It is published quarterly by **Nature Saskatchewan, 206-1860 Lorne Street, Regina, Saskatchewan S4P 2L7.**

CN ISSN 0006-5099

Editors: Kerry Hecker and Lowell Strauss P.O. Box 247 Simpson, SK S0G 4M0
Email: bluejay@naturesask.ca
Associate Editors: Mark Brigham, Marlene Evans, Vernon Harms, Stuart Houston, Josef Schmutz, Carol Scott.

EDITORIAL INFORMATION: Blue Jay welcomes all submissions, preferably by E-mail (although hand-written or typed manuscripts will be considered), polished or in need of some editorial assistance. All items for publication should be sent to the editors electronically by E-mail or on CD, or hard copies (in duplicate) may be sent by mail to the editors at the address above. Electronic submissions should only be submitted in Microsoft Word. Submission deadlines are 1 January (for the March issue), 1 April (for June), 1 July (for September), and 1 October (for December). For detailed information, see the "Guidelines for Authors" in Blue Jay Vol. 68 (2). Diether Peschken abstracts Blue Jay for Recent Ornithological Literature. Titles of Blue Jay articles are listed in BIOSIS.

Common and scientific (Latin) names are used for all species. Common bird names follow the Checklist of North American birds by the American Ornithologists' Union (7th edition, 1998); mammal names: Mammal Species of the World by Wilson & Reeder; butterfly names: The Butterflies of Canada by Layberry et al.;and names of reptiles and amphibians follow Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with comments Regarding Confidence in our Understanding, Sixth Edition, by The Committee on Standard English and Scientific Names (Brian I. Crother, Chair) (2008).

Photographs may be submitted as digital images or as prints. For the best quality reproduction on paper, high-resolution (≥600 DPI) images are required, although in some cases, lower-resolution images may provide sufficient quality. Digital images can be sent by E-mail directly to the editors, or if the files are very large, they should be put on a CD and mailed to the editors at the address above.

Although Nature Saskatchewan will make every effort to return prints to you, we recommend that you make a copy in case your items are lost in the mail. We encourage submission of photographic material with articles and welcome colour photos for Blue Jay covers.

Any material printed in Blue Jay may be reprinted for non-commercial purposes, without permission, but credit lines are both appreciated and good etiquette. Use of photographs and poetry requires permission from the photographer/author.

REPRINTS: a maximum of five reprints is available to authors free of charge for each article. Authors wishing to receive reprints should send their request to the Nature Saskatchewan office as soon as they receive notice that their article is accepted for publication.

SUBSCRIPTIONS: Subscription to Blue Jay is one of the benefits of membership in Nature Saskatchewan. A membership application form is included on the last page of each issue. Send all renewals, new memberships, donations and changes of address to Nature Saskatchewan (address at top).

Bulk subscription orders (minimum of five to one address) are available to society members and educational institutions at the rate of $15 (Can.) for the first subscription and $13 for each additional one. Outside Canada, fees are $18 (Can.). We do not collect GST on memberships or subscriptions.

Printed by Administration Centre Printing Services, Regina, SK.

THIS ORGANIZATION RECEIVES FUNDING FROM

Saskatchewan LOTTERIES

Nature SASKATCHEWAN

206-1860 Lorne Street, Regina, SK
Phone: (306) 780-9273 or
toll free 800-667-4668 (Saskatchewan only)
FAX: (306) 780-9263
E-mail: info@naturesask.ca
Web: www.naturesask.ca

MEMBERSHIP APPLICATION FORM

☐ New Member ☐ Renewal

Name (please print) .....
Address .....
City .....Prov..... Postal Code.....
Phone .....Fax ..... E-Mail.....

☐ Change of Address: Please write in new address above
☐ Gift Membership:
Name (please print).....
Address.....
City ..... Prov.....Postal Code .....
Phone..... Fax..... E-Mail.....

Category	**One Year**	**Three Year**	**Five Year**
Individual	☐ $25	☐ $65	☐ $95
Family	☐ $30	☐ $75	☐ $115
Student	☐ $15		
Senior (>64 years)	☐ $20	☐ $50	☐ $75
Outside Canada	☐ $30	☐ $75	☐ $115
Institutional	☐ $30		
Life	☐ $600		

I wish to make a tax creditable donation to Nature Saskatchewan:
☐ General Programs $ _____
☐ Grasslands Trust Fund $ _____
☐ Last Mountain Bird Observatory $ _____
☐ Stewards of Saskatchewan Programs $ _____

Fee Total
Nature Saskatchewan Membership $ _____
Nature Saskatchewan Donation $ _____
TOTAL $ _____

I would like to pay by: ☐ Cheque ☐ Visa ☐ Mastercard

Cardholder's Name: _____

Credit card number __/__/__/__/__/__/__/__/__/__/__/__/__/__/__/__/

Expiry date __/__/ __/__/ Signature _____

Make cheques and money orders payable to NATURE SASKATCHEWAN.
Mail to: Nature Saskatchewan
206 - 1860 Lorne Street
Regina, Saskatchewan S4P 2L7

* ***Do you know*** of any person interested in natural history and conservation who does not receive the Blue Jay? Please send their name and address and we will send a sample Blue Jay and an invitation to join our Society.

Renew by Phone!
Call toll-free: 1-800-667-4668 (Saskatchewan only) or (306) 780-9273
Fax (306) 780-9263
to renew by Visa or Mastercard