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Proceedings of the Third Prairie Conservation and Endangered Species Workshop

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Mona Regnier
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PROCEEDINGS OF THE THIRD PRAIRIE CONSERVATION AND ENDANGERED SPECIES WORKSHOP

February 1992
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DEDICATION

To the memory of Clint Jorgenson who died at Watrous, Saskatchewan on Wednesday, October 28, 1992.

Clinton was born on May 5, 1939 at Swift Current. He resided in the Stewart Valley district until 1944 after which time he moved to Swift Current where he received his education. From 1963 to 1965, Clinton attended Kelsey Institute of Applied Arts and Science where he received his diploma in Wildlife Management. Clint was employed by the Canadian Wildlife Service from 1966 to his passing. From 1973 onward, he worked as the Area Manager at Last Mountain Lake, the first bird sanctuary in North America. His love of wildlife and the outdoors made a lasting contribution to the conservation of Canada's wildlife heritage.

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3. PRAIRIE CONSERVATION ACTION PLAN

THIRD PRAIRIE CONSERVATION AND ENDANGERED SPECIES WORKSHOP - OBJECTIVES

The prairies of Canada support a major agricultural economy and a declining abundance of wildlife. Soil erosion and water quality threatens the long-term viability of agriculture. One-half of Canada's endangered and threatened birds and mammals share the prairies. Waterfowl populations have declined 60%. Wise soil, water, and land management are needed to solve these dependent situations. This workshop will address the issue of how to manage the prairies to promote sustained agriculture and to conserve the wildlife that are in jeopardy.

The objectives are:

1. To find economic and environmental linkages between agricultural and wildlife agencies that can be used to promote wise management of the prairies as suggested in the World Conservation Strategy.

2. To determine how to implement the World Wildlife Fund Canada's Prairie Conservation Action Plan which is the broad strategy to manage the natural portions of the prairie environment.

3. To encourage the recovery efforts on wildlife in jeopardy by determining the information needs for each species and possible management actions that could be undertaken.

This is an ambitious agenda but it is attainable because in western Canada we have many dedicated and talented people committed to the conservation of Canada's agriculture and wildlife. Together we can make it happen!

1. OPENING SESSIONS

CHAIRMAN'S OPENING REMARKS, THIRD PRAIRIE CONSERVATION AND ENDANGERED SPECIES WORKSHOP, BRANDON, MANITOBA FEBRUARY 14-16, 1992

R.D. Thomasson

Manitoba Natural Resources, P.O. Box 24, 1495 St. James Street, Winnipeg, Manitoba R3H 0W9

Good Morning. It has been my privilege to chair the Steering Committee that has organized this workshop.

This is, of course, the third workshop to be held on Prairie Conservation and Endangered Species. The first was in Edmonton in 1986 some six years ago. As I was thinking about the workshop origins I realized that it must have been about seven years ago that the real work of organizing that first workshop was underway. This workshop then marks the end of the first cycle and the start of the second cycle of focused interest in Prairie Conservation and Endangered Species activity. A lot has happened over the last seven years. Global events like the release of the Brundtland Commission Report, Our Common Future, and the recent Caring for the Earth Report, the successor to the World Conservation Strategy, have been major events. National events such as the initiation of the Endangered Spaces Campaign, the Report on the National Committee on the Environment and Economy, and State of the Environment Reporting have become well-known to us all. Closer to home, the Prairie Conservation Action Plan has been publicized and in Manitoba Endangered Species legislation brought into being. We have held workshops in each of the prairie provinces. There are a lot of accomplishments to look back upon over the last decade; no doubt there will be many more in the next.

With the foregoing in mind it seems most appropriate that we spend the next three days celebrating what has been done, looking toward what needs to be done, and replenishing our emotional batteries for the days ahead.

I, therefore, bid you welcome to this workshop and invite you to celebrate accomplishments, to re-commit projects which need to be finished, to commit to new challenges, and to return to the every day world refreshed in mind and in spirit.

ENDANGERMENT OF SPECIES - SOME THOUGHTS ON CAUSES

H.L. Sawatsky

Department of Geography, University of Manitoba, Winnipeg, Manitoba R3T 2N2

When we address the declared theme of this conference do we, I am moved to ask, include our own as one of the "endangered species?" In an age otherwise substantially defined by secularism, I find it paradoxical that, in large measure, our inherited cultural baggage, and indeed our own role projected, into the future, may still be said to be dominated by the content of the legend of Creation as told in Genesis, Chapter I. Verse 28 sums it up: "Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth." Further along, the emerging Judeo-Christian tradition bequeathed us the messianic approach - the redemptive one-shot solution - which we have, perhaps intuitively, thoroughly incorporated into the manner in which we address the perils we have largely ourselves authored.

As a predator, Man (*Homo sapiens*) was, not unlike other predators, an opportunist whose fortunes as a species waxed and waned with the fortunes of the prey. That is, until his innate sagacity caused him, very late in his history, to develop civilization, and the institutions and technologies to sustain it. Increasingly, he would be able to assert himself at the expense of competitive predatory species and, ultimately, to largely escape natural controls to his proliferation and the inevitable impacts which attended the continued, accelerated exercise of his innate predatory opportunism. Palpably, man had achieved ascendancy over his predator-competitors along the way to developing civilization. Small wonder, then, that he saw himself as a superior creation apart, upon whom devolved unrestricted license - and no reciprocal obligations - in respect to his conduct vis-a-vis all other species who shared their living space with him.

The cumulative product of man's sagacity did not, however, protect him entirely from catastrophic events. When these occurred, nonetheless, nature was perceived to be in revolt, and needful of "correction," correction to be achieved through intensified subjugation. Stories and myths, sacred and secular, infused successive generations with powerful messages. Jacob, the sedentary husbandman, obtains his hunter-woodsrunner brother Esau's birthright quite "properly," albeit, a dispassionate observer might argue, opportunistically and subject to an unconscionable contract. The masterless Esau was, after all, not "filling the Earth, and subduing it," and so, the message is, his rights were properly forfeit to one dedicated to a limited polyculture restricted to a few species of plants and a few of animals, all dedicated to the sustenance and expansion of the one dominant species.

Ultimately, man would become the ultimate domesticate, the ultimate monoculture, anthropocentrically viewing any realm outside his control, from his own utilitarian perspective, as howling wilderness, the abode of the sinister, of chaos, of the enemy as personified by unsubdued nature. The language which evolved, evoking man's relationship to the natural world, is such as is appropriate to struggle with an adversary whose subjugation is at the focus of high resolve. "Forcing the forest into retreat," "subduing the stubborn sod" were, from the utilitarian perspective, laudable endeavors in the ongoing struggle to order the wilderness. Indeed, the highest good, according to revealed prophecy and attainable only in the afterlife, was defined as admission to residence in a divine city, exquisitely ordered, a perfect cube all of precious metals and precious stones. - with but one single tree - its invited guests individuals of great virtue and exclusively of the one species which, since time immemorial, has known itself to be a separate and superior creation.

As a species we have shown ourselves to be largely unencumbered by a cultural imperative to exercise, at the very least, a broad, nonantbropocentric stewardship. If, as our civilization became more complex and our knowledge proliferated but our wisdom remained, at best, static, it should not amaze us that we pursued the creation and amplification of institutions essentially oblivious to all but their own narrow mandates.

In the course of exercising the mandates and performing the duties assigned them by society, our institutions project pervasive and, cumulatively, powerful messages. I shall cite only a few whose influence serves to illustrate. Municipal government was established on the prairies in 1880. Its revenue base was the land, evaluated, for revenue purposes, according to its perceived potentials for cultivation. Land which failed to meet the criteria for cultivation was designated as wasteland, to be taxed at a lower rate, but still taxed. It occurred to none to designate it, not wasteland, but ecological reservoir, vital to the continued well-being of the environment and hence of society-at-large, and to emphasize this realization by an insightful determination not to tax nature at all.

The Canadian Wheat Board, since 1935 the monopolistic regulator of much of the market in the primary products of prairie agriculture, provides another case in point. Its mandate is marketing, not ecology. Since its inception, producer access to the marketplace via the Wheat Board has been based on "improved," that is, cultivated acreage. Since 1935, the "improved" acreage registered by the Wheat Board has increased by well over 20 million acres. The producing acreage, on the other hand, has increased by less than half as much. The obvious conclusion to be drawn is, that in the pursuit of delivery rates and volume-entitlements, landowners rationally "improved," through permanent mutilation, in excess of 10 million acres with no realizahle agricultural potentials. They did this in the full knowledge, also, that they were, in any event, subject to taxation on the acreage in question and that, furthermore, most "natural" produce it might bring forth was, by law, the property of the Crown. The ultimate legacy is ecological and esthetic degradation of the landscape and the endangerment of species. Moreover, to the extent that such landscape-degrading "improvements" engendered economic costs, these were, and continue to be, deductible from realized taxable income. Indeed they have, at times, been directly subsidized by government.

The consequences have, naturally, become increasingly apparent. Countervailing thrusts, private and/or public, have been initiated to retain and restore elements of the diminishing ecological reservoir. Such initiatives, perhaps predictably, tend strongly to be addressed to specific species and/or designated areas. Control is achieved through the exercise of economic and/or political leverage. In consequence, such initiatives are vulnerable to finite time horizons associated with non-permanent, monetized terms of tenure and/or fluctuations in political will and commitment. Conservation initiatives addressed to private property and based on the payment of economic rent equivalents are highly vulnerable over time. Their funding base, whether from public or private sources, tends to be "soft," and limited to a predetermined maximum in the former, donor generosity in the latter case. The more successful their recruitment of desirable conservation habitat, therefore, the more dilute becomes the "bribe" they are able to offer. Economics has been described as the "dismal science," largely because of its failure to tell us with some certainty until after the event that which we would have preferred to know before. Moreover, it has caused us to largely confuse "value" with "price" and "growth" with "progress."

Even more sinister, I contend, is the concept of "opportunity cost," expressed as a discount rate. Rational decision-making in relation to conservation and retrieval in the context of the ecological reservoir inevitably leads to inhibiting conclusions. The more potentially deferred the anticipated benefits, the more inhibiting the opportunity cost. Thus, in terms of rational decision-making in the context of an annual discount rate of 6%, an investment in ecological retrieval must, over a 50-year term, generate imputed benefits equal to more than 17 times the initial economic commitment undertaken in a competitive, monetarily rational marketplace. In the course of a century, the factor becomes 320! Should the discount rate be 10%, the numbers are, for 50 years, 107, for 100 years 12528 times the initial investment. In other words, if rationally allocated funds borrowed at 10% do not promise deferred benefits in 100 years, equal to 12528 times the initial commitment, they will he diverted elsewhere.

That being said, it would appear to be in order to suggest that the strategy directed at promoting the future survival of endangered species must depart from the notion of buying our way out of an increasingly threatening bind. Rather, we must set about imbuing our institutions with operational ethics whose perceived messages cumulatively promote ecologically sound rational collective responses just as effectively as they have hitherto generated collective rational responses of an ecologically unsound, destructive nature.

The opening question was, "are we part of the theme of this conference?" Let's be candid about it, we are the theme! We have assessed our "dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth," and we have found it wanting. Those subjects of ours do not, to the best of our knowledge, ponder their endangerment and possibly imminent extinction. We do that, in the emerging conviction that the continued single-minded pursuit of the ascendancy and proliferation of our own sovereign species will, ultimately, deprive the sovereign as well as the subjects of the basis of survival. That being the prospect, we had better begin coordinating the messages emitted by our social, political, and economic institutions into a constellation of incentives such that rational decisions generate constructive outcomes. Farmers and landowners have consistently and pervasively demonstrated that they respond rationally to signals emanating from the various institutions to which they must respond. In respect to the endangered ecological reservoir the indicated imperatives are: "Retain; Redress; Retrieve." To achieve that, the signals must be brought into alignment. It's as simple—and as dauntingly complicated—as that.

AGRICULTURE - THE VILLAIN OR THE SALVATION OF WILDLIFE?

Crawford Jenkins

Director, Prairie Farming Program - North American Wildlife Foundation, 37 - 11 Street, Brandon, Manitoba R7A 4J2

The period beginning in the late 1800s to the present has seen many changes on the prairies. From an agricultural perspective it has been one of the most dramatic in world history. In a little over 100 years we have come from the oxen and single furrow plow era to space-age agriculture. We have advanced our production efficiency second to no other industry in the world and to no other country in the world - from where the early settler fed himself and his family to where one farmer now feeds over 30 people. But this has not been without cost. We have seen the total disappearance of some wildlife species and the steady decline of others to the point of being endangered. We have also seen the degradation of our soil base to where some of it should be placed on the endangered list. We all-too-often blame the farmer for this, but I don't believe he can be held solely responsible for either the demise of wildlife or the state of the land. The farmer's mandate was to produce food - and he did that the best way he knew how. We must also recognize that some wildlife species have thrived under our agricultural system; the White-tailed Deer (*Odocoileus virginianus*) is a good example.

I would like to focus the balance of my allotted time on one important species—a species that showed a rapid increase in numbers on the prairies—beginning about 1875 to where it reached some 255,000 in numbers by 1921; peaked in population at 297,000 in 1941, declined to 210,000 in 1961, to 154,000 in 1981 and 148,000 in 1986—a 50% drop in 50 years—and the decline has accelerated in the last years. The species to which I refer, of course, is the prairie farmer. He is an endangered species. And because he's endangered, it could place a great many more wildlife species in jeopardy.

If we can accept the premise that agricultural development has, in some way, been part and parcel to the demise of some wildlife species, lets follow the development of agriculture in western Canada and maybe we can better appreciate what happened.

When the white man came to the prairies it was subsistence living—he and his family lived in harmony with nature. He expanded his cultivated acres and gradually had produce to sell or trade. It was the best and easiest land to develop that was cultivated. The heavy bush, the hilly land and wetlands were generally left untouched—with the exception of the Red River Valley which was extensively drained. The native lands were home to wildlife like they had always been.

The drought and depression of the '30s, followed by the secoud world war marked the beginning of a massive change to the prairies. When the farm boys came home from the war in 1945 they took up the home farm, and often the neighbours farm as well, they brought land back into cultivation that had been abandoned—weather was in their favour, prices were in their favour, youth and courage were in their favour, and, most of all, they had improved technology and powerful equipment. Weed control chemicals and commercial fertilizer appeared on the scene. Big bulldozers, developed for the war, were available to clear land and drain sloughs. The second agricultural revolution was on—agriculture was king. Little thought was given to the capability of the soil to sustain agriculture—technology could compensate for soil degradation—or at least so we thought—all land was considered agriculture land. There was certainly less thought given to the wild critters that lived on the land. But why should there? After all, farmers make their living growing grain or raising cattle. For many years, intensified agricultural activities had little, or unrecognized, detrimental impact on wildlife or on the land base. So what was the concern?

We failed to recognize the relationship between our activities and the resources, both soil and wildlife. We are now experiencing the effects of our short-sightedness—both in terms of soil degradation and wildlife numbers.

The degradation of the agricultural land base as a result of outdated farming practices coupled with the decline of the farm population are two of the most perplexing issues in this country. Both will have a bearing on what happens to wildlife.

Why is the farmer so important? First of all, the farmer owns or controls over 90% of the habitat on the prairies—habitat which I understand is the home for many of the endangered species. In other words, the farmer owns the nursery. What he does with the nursery will determine the fate of many wildlife species.

In the past, it goes without saying that relations between farmers, wildlife and wildlife advocates have been anything but friendly. Ducks by the millions destroyed farm crops, Elk (*Cervus elaphus*) and deer trampled feed stacks and spoiled grain piles, Beavers (*Castor canadensis*) flooded hayland, and on and on it went. There was a time, not too long ago, when the farmer received no compensation for these losses—he was expected to bear these costs as a good citizen and conservationist. A farmer who had just lost 150 acres of barley to ducks is not very sympathetic to the cause of nature. Granted, compensation to farmers has improved over the last few years but in many cases, it is still inadequate.

Contrary to popular perception, the farmer is not your enemy—he is not adverse to wildlife. The problem is that he has never had a viable option. There was no money in raising wildlife. In the future, if we want wildlife, particularly those species that make their homes on the farm, that will have to change; the farmer must be given an option. Wildlife is in competition with grain and cattle. You can talk all you like about wildlife being a good indicator of the health of the land but the farmer has difficulty in relating a beautiful, clean, disease free crop of wheat that has just been ruined by wildlife to the importance of an owl or a falcon. When he can make that relationship in economic terms, he will be more receptive. In other words, if you expect the farmer to raise wildlife for the benefit of society, society had better be prepared to pay.

The opportunity to directly or indirectly place wildlife as a product of the farm has never been better. In the next few years, we will see changes on the farm scene every bit as dramatic as those of the late 1800s or the post-war era. Sustainable agriculture is the buzz word. There is a growing concensus that sustainable agriculture involves giving much more attention to the environment and the social and economic consequences than in the past. However, all of these sustainable development concerns will be fertile ground for increased conflict. Farmers do not change without good reason.

However, we cannot continue to farm the way we are; farm economics will dictate that; the capability of the soil to sustain agriculture will dictate that; and climate changes, if they materialize, will dictate that. The environmental movement will have a say in how we farm—just look at what the animal rights movement is doing. Reduction in agricultural subsidies currently under negotiation with the General Agreement on Tariffs and Trade talks will change farming practices; and probably the most significant impact will be as a result of what happens in China and Russia when high-tech agriculture catches hold and they no longer need our wheat.

The next decade or two will see a major change in the farmer himself. The average age of Manitoba farmers is 57+ years. These guys don't have many years left—physically, and some of them unfortunately, have damn few years left economically. Who is going to take over the land? There is not much incentive for a young man to go into farming today.

The farm scene has two ways to go—big corporate farms owned by big business or corporate farms owned by farm families. In either case, farming will be big business. The family farm, as a way of life is a thing of the past.

If we go the route of the big business corporate farm, how the owner sees the farm will largely determine what is produced on that farm. If the corporate board has a soft spot for wildlife, it may set aside some land for wildlife for the pleasure of the board and the company's employees. But if the farm is strictly business, wildlife will have no place—unless it pays its own way. The family corporation may have values that are different because the family is closer to the land. Hence, the need to support the family farm.

We are in a very complex dilemma that is going to test the ingenuity and skills of all concerned if it is to be solved to our mutual satisfaction.

What has to be done? First of all, we have to stop throwing darts at each other. We have to develop a partnership—we have to coexist on the same landscape—and there is room and need to do that.

Second, we must somehow enact a change in farmer attitude. There is a perception amongst many farmers that you're not a farmer if you don't make your living from growing grain or raising cattle. But, a dollar made from selling a recreation service or hunting rights is of equal value to one made from wheat and it may be more environmentally friendly.

Third, we have to change the attitude of the agricultural bureaucrats who think that the only solution to the farm crises lies with agriculture. They fail to recognize the opportunities of interfacing with other resource disciplines for the benefit of the farmer or the land.

Fourth, we have to farm in accordance with the capability of the land base so as to sustain agricultural production but not at the expense of other natural resources.

Fifth, we have to change agricultural policies to make them more environmental friendly. But you won't do this by confronting the farm organizations or government. You have to come at it from the side, such as the Green Plan; through the back door if you like.

Sixth, we should be looking at ways of keeping the money that is currently going to the farmer as farm subsidies still flowing to that farmer. Subsidies have to be decoupled from agricultural production and coupled to the environment.

We have to support conservation farming. Farmers will listen to you and will be more receptive to implementing environmental farm plans if you have something to put on the table—so we pay the farmer not to produce more grain but to be a steward of the ecosystem. Ontario is leading the way in this respect. There, all 40,000 farmers are being encouraged to have an environmental farm plan by the year 2000.

Seventh, we have to work with the kids—the 4-H clubs, the schools, particularly the city kids because they have the least understanding of the rural scene.

Eighth, we have to find new and innovative ways of raising money for wildlife; forget the governments.

Ninth, we must form partnerships—we must cooperate because whoever thinks he can go it alone is dead.

I wouldn't want to leave you thinking that nothing is happening. Agriculture is rising to the challenge to stop soil degradation. Under federal/provincial soil and water accords, "Farming for Tomorrow" program will see some $18.0 million spent in Manitoba over a 5-year period. Soil conservation is the main thrust but it also includes conversion of fragile lands to a more stable use. Prairie Farm Rehabilitation Administration is administering the Permanent Cover Program aimed at taking 600,000 acres out of cultivation by seeding to forage or trees for terms of 10 or 20 years. The North American Waterfowl Management Plan is a 15-year $1.5 billion program aimed at establishing and securing some 3.6 million acres of habitat in Canada - the majority on the prairies. Much of this acreage will be cultivated land converted to dense nesting cover.

The Manitoba Conservation Districts have really come of age in the past few years. Initially, program emphasis in most districts was drainage with minor soil programs. More recently programs have broadened to include wildlife habitat and water management.

Manitoba Agriculture has just released a strategic plan called "Vision for the '90s." Granted the emphasis is on production and marketing but they are looking at sustainable development and value added crops.

The federal government's "Green Plan" is focusing, among other things, on initiatives that will include measures aimed at halting soil degradation and enhancing compatibility between agriculture and wildlife.

In summary, I think there is a good reason for being where we are. There is certainly good reason to have to change. We must recognize that we cannot enact change on our own. We must work together but we must recognize that the farmer is the key to much of our success.

SOME THOUGHTS ON AGRICULTURE-PRAIRIE CONSERVATION INTEGRATION

Garry Trottier

Canadian Wildlife Service, Room 210, 4999 - 98 Avenue, Edmonton, Alberta T6B 2X3

First of all let me convey a sincere apology from Director, Gerald McKeating, who was unable to participate on this morning's most important panel, and of course, could not attend this workshop. Due to the federal government expenditure freeze Canadian Wildlife Service (CWS) attendance had to be reduced and Gerry reasoned that it was more important for technical staff to attend than himself.

Both Gerry and I congratulate the organizers for focusing on the issue of integrating agriculture and prairie conservation. We are glad to be among conservationists, including both producers and wildlifers and my fellow panel members, to discuss the use of the land.

At one time or another I think we have all heard the comment from farmers—wildlife doesn't pay the bills so why should I save their habitat. This feeling has certainly changed forever the way wildlife stakeholders do business on the prairies.

As wildlifers we, and I am speaking now for all wildlife interest groups, have been working very hard over the last few years to secure marginal acres and improve cultivated acres for wildlife habitat. The strategies have been many, and, I believe, very proactive.

Allow me to take a few minutes to comment on some of these efforts and I apologize for not mentioning all the prairie programs in effect.

Land acquisition is ongoing on a very limited scale. This is an expensive option and is used only to secure outstanding or rare examples of habitat. Local governments and landowners are often wary because such efforts are perceived to threaten commerce and the local tax base. However, proponents know this is the surest way to protect habitat.

We have seen much progress in integrated planning and management decisions. This includes the formation of conservation districts, agricultural service boards, and integrated decision-making at the municipal level where the work gets done and where wildlife stakeholders have been able to become part of the land management process.

Leasing to protect critical habitat is a major activity. It is common to several provincial wildlife programs and the North American Waterfowl Management Plan (NAWMP), including the Adopt a Pothole and the HELP (Habitat Enhancement Land Use Program) programs in Manitoba, the Prairie Pothole Project in Saskatchewan, and Prairie CARE (Conservation of Agriculture, Resources and the Environment). Also there are the non-waterfowl programs of Buck for Wildlife in Alberta, and the Critical Wildlife Habitat Program and Tall Grass Prairie Project in Manitoba. Wildlife Habitat Canada (WHC) has cost-shared many of these provincial initiatives. In essence landowners are paid a fair rental rate for leased land but the technique is a gamble as it protects landscape only while there is money available. And as you know, funding is getting more difficult to obtain. On the other hand leasing is the option most preferred by landowners.

The Prairie Farm Rehabilitation Administration (PFRA) is reclaiming cropped marginal lands to permanent cover under the Permanent Cover Program (PCP) and already we are into the second generation or PCP2. Wildlife programs have been attempting to piggyback wherever there is an opportunity to increase wildlife use by offering further incentives so farmers will alter their forage conservation and grazing management practices, or plant native seed mixes, or rehabilitate wetlands. Unfortunately, few wildlife advances have been realized under this program so far and I hope the reasons for this can be addressed during this workshop.

There are also efforts to provide producers with financial incentives to adopt conservation farming techniques. An important component of the NAWMP, this involves fair incentives paid to farmers for modified agricultural uses which are wildlife-friendly.

Wildlife dollars are being used to support on-farm projects that demonstrate conservation farming techniques. Under Prairie CARE planned grazing systems, stubble mulching, chemical fallow, underseed clover, direct seeding (zero-till), and winter wheat projects are funded so that farmers can experiment with new technology without incurring financial risks. This is an educational technique to encourage broad adoption of desirable practices.

Support for research into crop management systems which have potential to provide wildlife habitat is coming from wildlife interests. For example, Ducks Unlimited is directing funds to develop winter wheat cultivars and management techniques because this cropping system has a unique potential to provide safe nesting cover for ground nesting birds including ducks.

Another important activity is research on the wildlife responses to conservation farming techniques. CWS, the Institute for Wetlands and Waterfowl Research, Saskatchewan Wetlands Conservation Corporation, and university interests are involved in directed studies funded by the Evaluation Program of the NAWMP.

The above are just a sample of the numerous cooperative approaches with agriculture. Most put money directly into the hands of agricultural producers. On balance then, wildlifers are already heavily integrated with agriculture.

We have also lobbied and won significant improvements in the crop damage prevention and compensation programs. And last but not least extensive lobbying effort has been expended particularly by WHC for adjustments to agricultural policies which would tie agriculture support programs to conservation.

For the most part our efforts have been successful with one disappointing exception—agriculture support programs. And here I will quote what Dr. Fred Bentley, former Dean of Agriculture at the University of Alberta, recently had to say about the new programs, particularly GRIP, "the Gross Revenue Insurance Program, has encouraged bad farming practices by paying on the basis of seeded acreages." On a trip between Wainwright and Medicine Hat Dr. Bentley was appalled to see long stretches of bare-tilled soil left for overwintering and he stated, "I don't think people should be paid subsidies on an acreage basis to farm as badly as I saw on that trip." And in another testimony just a few days ago Western Canadian Forage Processors complained that because GRIP does not cover forage production they anticipate an 18% reduction in seeded forage acreage this coming year. Such shortcomings do not bode well for soil and water conservation.

I don't want to belabour the obvious, but our greatest challenge is that our conservation efforts cannot compete with or neutralize the negative effects of such policies on wildlife habitat. Until there are substantial changes to agricultural policies net habitat loss will be a fact of life.

Solutions to this dilemma remain the challenge of this workshop. As you deliberate keep in mind that we have to build on the positive actions that are currently being undertaken by federal and provincial wildlife habitat programs, conservation organizations, environmental groups, and conservation-minded producers.

Now I think we should all be aware that producers are honestly concerned about their conservation image. I had an opportunity three weeks ago to attend the Alberta Conservation Tillage Society Workshop in Edmonton and I was encouraged to learn that the agriculture interests want to improve their image as stewards of the land and the environment. As one producer and conservationist, Elmer Kure put it, and I quote, "farmers have not done a good job of getting the conservation message out because of their narrow pro-production politics. It's time to put aside the B.S., we need a positive image of how we manage the land, or the four percent of us who still live out there will not be supported by society as we know it today."

While acknowledging that it is necessary to break and drain some of the land to make a living Elmer, pointed out that the need to completely eliminate the rough, marginal acres in order to make a buck seriously tarnishes agriculture's conservation image and is economically unsound.

Even though the agricultural community acknowledges a conservation image problem one has to sympathize with producers because the politico-economic system has let them down. At this time farm survival is the number one priority. Therefore, we must be sensible in directing our criticism concerning conservation issues and land use because producers are getting a little bit weary of all the nit-picking. The fact that they may feel threatened can result in a backlash against the conservation lobby.

An example of a backlash has just recently surfaced in Alberta. Livestock producer associations are lobbying to have administration of all agriculture dispositions on public lands transferred from the Department of Forestry, Lands and Wildlife to the Department of Agriculture, in essence from an agency geared to meet the needs of a broad spectrum of land users to one with a much narrower focus. Why? Because recreationists and conservationists have largely given the impression that they don't want cattle on public lands. I don't believe that should be our view.

In this regard, we must keep in mind that landscapes supporting livestock grazing are some of the most extensive and well-managed tracts of native prairie habitat left. Ranching has been instrumental in protecting prairie from other destructive interests. Ranchers are strong allies in conservation and must be treated as such. So let's strengthen our linkages with these people, not alienate them.

Now, before I close, Gerald McKeating wanted me to mention some new initiatives that CWS will be taking to address wildlife habitat and endangered species conservation needs on the prairies.

Under the federal Green Plan CWS will initiate two programs—Endangered Spaces and Safeguarding Healthy Ecosystems. For the Prairie Biome we will hire a Nongame Biologist and secure a program budget of $80,000 over 5 years. In addition, a Partnerships Coordinator will oversee a 4-year budget of $350,000 involving research, possibly land acquisition, and cooperative land-management agreements. We expect this latter activity to result in new ventures not only with PFRA, Agriculture Canada, and the Department of National Defence (DND), but also with provincial counterparts where opportunities arise.

Also of note, CWS has initiated two research projects which will provide some much needed information on avian communities: 1) in wooded draws, and 2) on Heritage Farmsteads in Saskatchewan. Results from this work will help CWS provide recommendations to agriculture and wildlife agencies on management of such habitat throughout the Prairie Biome.

And finally, as I am sure you are already aware, we anticipate signing a Memorandum of Understanding in March with the DND for designation of approximately 480 km^2 of the Suffield Block in Alberta as a National Wildlife Area (NWA). This will be a significant contribution to the goal of protecting 12% of the country as defined in the Green Plan. Incidentally, some of this proposed NWA is currently managed cooperatively for wildlife and livestock grazing with excellent results.

In closing, there are some important challenges that you as delegates should consider during this workshop. All offer opportunities for conservation to benefit. Producers will be looking to diversification as a means to survive. What suggestions can we make in that regard? Agriculture support policies will continue to drive land management practices so we must keep pressing for conservation links. And stewardship must take a higher profile in our efforts to integrate with agriculture.

2. AGRICULTURE AND WILDLIFE

SOIL CONSERVATION, DIRECT SEEDING AND WILDLIFE. WHERE AGRICULTURE, THE ENVIRONMENT AND WILDLIFE CAN ALL BENEFIT

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ABSTRACT

Across the prairie provinces, traditional agricultural practices have dramatically changed prairie ecosystems. Today, mounting agricultural, soil and water conservation concerns along with increasing concern about wildlife diversity are demanding changes to traditional agricultural practices. Direct seeding, an agricultural practice where an annual crop is seeded directly into standing stubble, may hold the key to better prairie soil, water, and wildlife habitat conservation. This session will highlight: 1) the potential soil, water, and wildlife habitat conservation benefits to the prairies, 2) the practical observations of a direct seeder, and 3) a practical "How To" video about direct seeding, soil/wildlife conservation, and forage seeding in saline and marginal agricultural lands.

DIRECT SEEDING: POTENTIAL SOCIO-ECONOMIC AND CONSERVATION BENEFITS

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INTRODUCTION

For the purpose of this paper, I define direct seeding (zero tillage) as planting small grain crops into standing stubble without any tillage operations. In western Canada, the spring-seeded crops—wheat, barley, flax, and canola (or rape), and fall-seeded winter wheat and fall rye, are the major zero-till crops. Sunflower, corn, oats, and spring rye are less important as crops.

Direct seeding requires precision technology and superior management. During harvest of the previous crop, the straw is chopped and spread evenly with the chaff on the field. For fall seeding, one or more herbicides are sprayed to kill fall-germinating weeds, then a shallow-depth, precision seeding is done in late August to mid-September.

Herbicides and fertilizer are usually applied in spring for spring-seeded crops. Weeds are "burned off" with a non-selective herbicide, usually glyphosate, trade name Roundup®, to kill all green growth prior to crop emergence. After either the fall- or spring-seeded crop is up and growing, herbicides are used selectively just as in conventional crops.

Cover increases with the growing season. Fall crops emerge in fall, grow until freeze-up, then die back; they re-grow from the crowns early in spring (April) and get well ahead of spring-seeded crops. Farmers harvest from as early as late July to mid-September, often by straight combining.

As the ecology of the fields changes with the years, physical and biological factors mould and interact; productivity may decrease initially, to rebound and improve with time. Experienced farmers generally see yield improvements in individual fields after three or more years of direct seeding. With proper management, environmental benefits accrue, assuring economic and wildlife benefits in step.

ENVIRONMENTAL BENEFITS

Soil

Direct seeding has been shown to reduce erosion by as much as 90%, and retard and resolve salinization processes. The decomposing plant materials increase pore and root channel size; facilitate aeration, microbial, earthworm, and insect activity; and thus enhance tilth and organic development.

Moisture

Stubble retains up to 50% more field moisture than cultivated cropland. Standing stubble traps much more snow, funnels meltwater and rainwater into the soil through root canals and earthworm burrows, and cools and reduces evaporation by surface winds. With increased organic content, the soil can absorb and hold more water in the root zone.

Environment

Better moisture retention on zero-till fields helps reduce ponding, runoff, water erosion, flooding, sedimentation and pollution, and balances summer stream flows. Erosion is almost eradicated, and reduced soil salinity allows for new plant growth in fields and headlands.

Pesticides and fertilizers are better kept on the target areas, reducing overland movement into neighbouring farms, human habitations, wetlands, and waterways. Modern herbicides used in direct seeding are relatively shorter-lived (Sprinkle et al. 1975), less toxic, and more efficient than the soil-incorporated types; they require less active ingredient (up to 20% less) and so can actually reduce the total amount of active product applied. Glyphosate (Batt et al. 1980) and POAST® (Batt et al. 1985), two major herbicides used in zero-tillage, were shown to have no effect on egg hatchability.

More fungicides may be needed to combat diseases that proliferate in the moister environment of the zero-till field. Insecticides requirement should decrease over time as insect/invertebrate communities achieve a better balance by harbouring a larger compliment of predatory insects. As well, predatory birds and small mammals can help control insect pests (Warburton and Klimstra 1984, Basore and Best 1982).

ECONOMICS

We must keep in mind that it takes several years for the ecology of a field to change under a new cropping regime, and for increasing productive capacity to translate to economic improvement. However, in the case of direct seeding, several indicators may appear along the way. The farmer sees improvements immediately in some aspects of management: savings in time and fuel (up to 32-50%), reduced machinery depreciation and maintenance (15%), and even the elimination of stone picking. Yields will eventually improve, at least in dry years. Net savings have been estimated at 15-20%.

Over time, summerfallow should decline as annual moisture savings allow, extended crop rotation will break disease/pest cycles, and improving technology will make herbicide, fertilizer, and other cropping inputs more efficient. In the future, progressive provincial and federal agricultural policies must be moulded to facilitate rural conservation objectives and provide a more friendly economic environment for direct seeding on the dry prairies.

WILDLIFE BENEFITS

The retention of stubble cover year round on large acreages of prairie farmland, in place of intensive cultivation, will create a new landscape which should benefit many species of wildlife. In farmlands associated with a diverse mix of natural habitats, this potential is especially enhanced. There are presently very little data to test this theory because such landscapes are few and only recently emerging. However, there have been, during the prairie-wide conservation movement of the 1970s and 1980s, many indications that direct seeding could provide significant wildlife benefits and that this technique will become established on many farms over the 1990s.

It is well-known that many species of birds and mammals use uncultivated stubble fields in all seasons to feed on waste grain, weeds, insects, and small vertebrates, and as cover from the elements and for nesting. Cowan (1982) documented 27 species of birds and 16 species of mammals inhabiting direct seeded fields in Manitoba; of these 14 bird species nested in the stubble. Higgins (1977) in North Dakota and Basore and Best (1982) in Iowa found a rich community of birds and mammals on zero-tilled land.

I will describe some benefits to ground nesting birds, based on my own and others' research on duck production in spring direct-seeded fields in Manitoba (Cowan 1982), and fall direct seeding (winter wheat) in North Dakota (Duebbert and Kantrud 1987). Five species [Mallard (*Anas platyrhynchos*), Northern Pintail (*A. acuta*), Blue-winged Teal (*A. discors*), Gadwall (*A. strepera*), and Northern Shoveler (*A. clypeata*)] nested in these fields. Nest densities ranged as high as five nests per 100 acres (quarter-section field). In Manitoba, nests were located before seeding and protected from drill damage; success rate was 60%. Predation was much less intensive in the direct seeded fields than in the neighbouring cultivated fields (e.g., 40% and 91%, respectively). In the North Dakota winter wheat crops, the adjusted success rate (Mayfield) was 27% (Duebbert and Kantrud 1987). By comparison, nest densities in native cover types in and adjacent to farm fields in the prairie potholes region are generally much higher, however, nest success rates are consistently below 15%, the rate required to sustain duck populations (Greenwood et al. 1987). This can be categorized as a nesting trap.

How beneficial zero-tillage will be to wildlife in the future depends on how the technology evolves. For instance, a recent preliminary study at Minnedosa (Fisher, pers. comm.) showed a reduction in nesting effort from the earlier study by Cowan (1982), probably because of declining breeding populations and the use of seed drills that are agronomically efficient but bury a good portion of the trash cover. Nest losses were high, again due to the types of drills used: the hoe openers were relatively wide and so dragged the nests, spread and buried the eggs, and wide packing wheels left no room for nests to escape being crushed. During my own study (Cowan 1982), where narrow disc openers and packing wheels were used, few eggs were destroyed and some hens returned and resumed incubating, with a 50% success rate. It thus behooves wildlife managers to promote this latter drill type where feasible and perhaps invest in technological development.

Here are a final few points regarding wildlife in direct seeded fields. The several studies done so far point to the probable development of better balanced communities of animals utilizing stubble fields. There is a large reduction in field traffic and thus a reduction in annual impacts on field and slough edges, tree bluffs, and other habitats within and adjacent to the fields.

Better retention of available water in the soil due to retaining stubble may reduce runoff to the low spots, eventually decreasing the number and size of ephemeral ponds and possibly bird use. Ponding causes delays and disruption in seeding, late crop ripening, and increased cost for the farmer. We do not know the total extent and ecological effect of this drying phenomenon as yet. Access to more arable acres could alleviate many of the economic concerns of agriculturists and promote a better attitude toward wildlife habitat in general. In the end, it could prove beneficial to the movement for conservation, multiple-resource management, and sustainability.

SUMMARY

Direct seeding holds great potential to alleviate the environmental woes that excessive cultivation has brought on millions of acres of cropland across North America. It can increase soil productivity and remove many of the inappropriate management treatments presently in vogue. At the same time, direct seeding can benefit wildlife by providing large acreages of safe habitat in otherwise sterile landscapes.

The optimistic view presented here is predicated on the bottom line requirement that the direct seeding system be economically feasible and acceptable to the farmers who must depend on it to provide profitability. But this will happen on a permanent basis only when all of the pieces come together. Research, development, trial, acceptance, and economic factors must be driven by government policies that provide the incentive and the means. We are a long way down that road today but there are some miles yet to travel.

LITERATURE CITED

Basore, N.S. and L.B. Best. 1982. The effects of no-till farming on nesting birds. 44th Mid-west Fish and Wildlife Conf., Des Moines, Iowa.

Batt, G.D.J., A. Black and W.F. Cowan. 1980. The effects of glyphosate herbicide on chicken egg hatchability. Canadian J. Zoology 58:1940-1942

Batt, G.D.J., A. Black and W.F. Cowan. 1985. The effects of Poast and Hoeschst 00736 herbicides on chicken egg hatchability. Delta Waterfowl Research Station, Delta, Manitoba. (unpub.rep.)

Cowan, W.F. 1982. Waterfowl production on zero tillage farms. Wildlife Society Bull. 10:305-308.

Duebbert, H.F. and H.A. Kantrud. 1987. Use of no-till winter wheat by nesting ducks in North Dakota. J. Soil and Water Conservation. 42(1): 50-53.

Greenwood, R.J., A.D. Sargeant, D.H. Johnson, L.M. Cowardin and T.L. Shaffer. 1987. Mallard nest success and recruitment in prairie Canada. Transactions of the 52nd North American Wildlife and Natural Resources Conference. pp. 298-309.

Higgins, K.F. 1977. Duck nesting in intensively farmed land in North Dakota. J. Wildlife Manage. 4(2):232-242

Sprinkle, P. W.F. Meggitt and D. Penner. 1975. Rapid inactivation of glyphosate in the soil. Weed Sci. 23: 224-228

Warburton, D.B. and W.D. Klimstra. 1984. Wildlife use of no-till and conventionally tilled corn fields. J. Soil and Water Conservation 39(5):327-329.

HOW AGRICULTURE AND WILDLIFE BENEFIT FROM DIRECT SEEDING ON MY FARM

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Tisdale, Saskatchewan, "The land of rape and honey." This slogan was used for many years in my home town and has grabbed a lot of attention over the years. Now, with the introduction of canola, the slogan has become out-dated but it does illustrate the diversity of cropping opportunities in northeast Saskatchewan. On our farm we grow pulse crops, oilseeds, pedigreed grass seed, Alfalfa (*Medicago sativa*), and the more traditional cereal crops. All of these are now direct seeded. We are in the grey black soil zone with a rolling topography so our land is very subject to water erosion and during severe winds the soil can become airborne.

In 1955 soil conservation started on our farm because of uncontrolled erosion. At that time I was not old enough to be very involved with the decision-making but I can remember how my father agonized over this problem. He started grassing water runways which helped, but this was not the total solution.

The next major step occurred when I became involved in the farm and we started continuous cropping some twenty years ago. Conventional continuous cropping is very labour intensive and requires high input costs. In an attempt to reduce these costs I started experimenting with direct seeding, which is the reason I am here today.

THE BENEFITS OF DIRECT SEEDING

The economic benefits from direct seeding were pretty much what I expected; a significant reduction in input costs, some increase in yield, and total control of soil erosion.

Having been involved in local wildlife and habitat retention programs for years, I did foresee direct seeding as being beneficial to wildlife but I was pleasantly surprised at how quickly some of these benefits became apparent. There was increased nesting of the larger species such as Sharp-tailed Grouse (*Tympanuchus phasianellus*) and ducks. I noticed an abundance of mice and small birds. Also, the population of Red Foxes (*Vulpes vulpes*) and Coyotes (*Canis latrans*) multiplied, no doubt due to the fact that their prey was more abundant! In my opinion this increase results from:

1. Stubble left standing over winter to collect snow, provides food such as grain thrown over combines, which is readily accessible because it is on the soil surface.

2. The snow provides protection for Sharp-tailed Grouse to burrow in during cold winter nights. I'm told that the ability to do this is very important for Sharp-tailed Grouse survival in our cold winters.

3. The trapped snow allows for a much slower runoff in the spring resulting in less silt deposits in our waterways and an improved habitat for fish and other aquatic wildlife.

4. Stubble left standing provides immediate browsing for deer in the spring. I have often seen large herds of deer feeding on my fields in early spring. They appear to be after the volunteer grain growth from the previous fall.

5. Again, spring stubble provides cover for nesting birds, particularly Mallards (*Anas platyrhynchos*). I have also noticed that if a duck's nest is destroyed by direct seeding, they will often nest again in the same spot.

CHEMICAL WEED CONTROL IN DIRECT SEEDING

No doubt many of you are thinking that direct seeding requires chemical weed control as indeed it does. I also know that you are very concerned about the impact of herbicides on our environment. This may sound contradictory, but I feel that the type of chemical control used by a direct seeder is (compared to the alternative) beneficial to wildlife.

A ground rig with shielded booms is the type of spraying unit used on my farm. For direct seeders the most effective herbicide is glyphosate (trade name Roundup®), generally used in a split application, one half litre per acre in the fall to control perennial weeds and winter annuals, plus one half litre per acre in the spring just prior to seeding. This practice results in an increase in the amount of glyphosate used but conversely a decrease in the use of other, possibly more environmentally unfriendly herbicides, thus having a positive, overall effect on wildlife, soil, and water.

Glyphosate is known to produce no particular adverse effects to mammals, birds, or aquatic organisms because of its low toxicity and quick soil absorption. Speaking as an agricultural producer, actively practising conservation on my farm, I feel fortunate to have access to a herbicide of such efficacy, both agriculturally and environmentally.

Thank you for this opportunity to share with you some of the things that we are doing on our family farm, in attempting to preserve the land and its wildlife for future generations.

HAYING AND GRASSLAND BIRDS: INTRODUCTORY REMARKS

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It seems that there is not a lot of structured research currently being done on the effects of haying on wildlife. Most people I spoke to gather information on haying incidental to other work and did not feel they had sufficient data to present a paper at this workshop. They did share their general impressions with me and I have included them where possible.

Most such research was conducted in the United States decades ago because of haying's suspected deleterious effects on waterfowl and pheasants. Although the effects of haying on gamebirds are known, little progress has been made in improving avian productivity because instituting widespread changes in haying practices is difficult and expensive.

We need to become more aware of the relationship between haying and birds in Canada. There are two main reasons. The vast majority of grassland that was the nesting habitat of prairie birds has been broken so management of remaining habitat becomes more vital to wildlife. The lack of market for grain and deterioration of prairie soils is leading to farmers being encouraged to convert cropland into forage.

Conversion to forage is certainly a positive step for wild birds because their productivity in croplands is extremely low (Milonski 1958, Rodenhouse and Best 1983, Cowardin et al. 1985) and cover provided by forage is very welcome. However, forage can be a trap that offers suitable cover and attracts nesting birds whose nests are then destroyed by forage harvest. The difference between a hayfield being highly productive for birds or a reproductive bust is often only a matter of days. The purpose of this session is to reacquaint people with the impacts of haying on birds and examine policy and haying practices. The goal is to find ways to encourage conversion of crop to forage and the management of forage to maximize avian productivity within the bounds of what is economic for agriculture.

The three papers in this session will outline current haying practices and policies and document decreased productivity in game and nongame birds occupying hayed habitats. The papers attempt to offer suggestions for changes in practice and policy that might benefit grassland birds. The remainder of the session will be used for discussing these suggestions and any that may be offered from the floor.

LITERATURE CITED

Cowardin, L.M., D.S. Gilmer, and C.W. Shaiffer. 1985. Mallard recruitment in the agricultural environment of North Dakota. Wildl. Monogr. 92:1-37.

Milonski, M. 1958. The significance of farmland for waterfowl nesting and techniques for reducing losses due to agricultural practices. Trans. N. Am. Wildl. Nat. Res. Conf. 23:215-227.

Rodenhouse, N.L. and L.B. Best. 1983. Breeding ecology of Vesper Sparrows in corn and soybean fields. Am. Midl. Nat. 110:265-275.

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EFFECTS OF HAYING ON WATERFOWL, UPLAND GAME BIRDS AND SHOREBIRDS

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The deleterious effects of haying on productivity of waterfowl, upland game birds, and, to some extent, shorebirds have been studied and I present a brief overview of their findings. I regret that this is a literature review but the waterfowl expert intended for this slot had to withdraw.

The effects of haying fall into two categories—the change it produces in the attractiveness of cover and the altered productivity of the birds that are attracted to nest in the hayed lands.

WATERFOWL

Numerous studies show undisturbed grass cover is more attractive to hens than areas with reduced residual vegetation (Evans and Wolfe 1967, Miller 1971, Oetting and Cassel 1971, Page and Cassel 1971, Elliott and Linder 1972, Kirsch et al. 1978, Voorhees and Cassel 1980, Livezey 1981). Haylands do not become attractive until some regrowth has occurred. The dates when sufficient cover is offered vary with plant species, location, weather, and duck species. In general, early nesters use hayfields for renests while late nesters use it for first attempts and renests (Milonski 1958, Gates 1965).

The negative impact of haying on productivity has been shown time after time (Labisky 1957, Gates 1965, Evans and Wolfe 1967, Elliott and Linder 1972, Cowardin et al. 1985). Many of these studies present simple success data uncorrected for different exposure times which results in an overestimate of success (Klett and Johnson 1982). Since success rates in hayed areas are low (maximum 22%) even without correction it is clear that, in general, haying precludes waterfowl attaining the minimum of 15% success (Mayfield adjusted) necessary to maintain stable populations (Cowardin et al. 1985).

Several studies have shown virtually every nest active at the time of haying is destroyed by mechanical means or immediate avian predation upon exposure at harvest time (Evans and Wolfe 1967, Labisky 1957). Losses of hens are not high (Milonski 1958, Cowardin et al. 1985). The cutting date is a critical factor in nest success in hayland and a two week delay caused for example by wet weather, can markedly increase nest success (Cowardin et al. 1985, Labisky 1957).

Rights-of-way are a special case. In areas of intensive agricultural activities, roadsides may be the only habitat with cover available to wildlife. There is also public land. Depending on local practices roadsides may be cut several times, cut later than hayfields, cut only some years, or not cut at all. Oetting and Cassel (1971) recognized wildlife agencies may be missing the boat if they do not utilize the potential of rights-of-way since they offer 20 million ha of habitat in the United States alone. Several studies have shown them to be very attractive to birds (Milonski 1958, Evans and Wolfe 1967, Oetting and Cassel 1971, Page and Cassel 1971, Higgins 1977, Voorhees and Cassel 1980, Klett and Johnson 1982, Cowardin et al. 1985). Success rates are higher in unmowed or late cut rights-of-way than in conventionally mowed areas. Their value is extremely variable depending on haying and predation impacts. Success varied from 3% to 83% in unmowed or delayed cut rights-of-way but was over 30% in most studies. The wider highway rights-of-way enjoyed, generally, better success than ditches along municipal roads. In one mowed right-of-way, success was lower at 15%.

Roadsides are linear habitat. They serve as travel lanes for mammalian predators so nests may be more vulnerable. If the roadway includes a fenceline productivity will be adversely affected also by avian predators (Milonski 1958, Evans and Wolfe 1967).

UPLAND GAME BIRDS

In general tame hayland does not seem very attractive to Greater Prairie Chicken (*Tympanuchus cupido*), Sharp-tailed Grouse (*T. phasianellus*), or Gray Partridge (*Perdix perdix*) since they prefer abundant

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residual cover (Kirsch et al. 1973, Kirsch et al. 1978, Smith et al. 1982, Church and Porter 1990). Greater Prairie Chicken and Sharp-tailed Grouse will use hayfields that have been idled or are cut every other year (Kirsch et al. 1973, Kirsch 1974). Native tall grass prairie requires some mowing to remain attractive to Greater Prairie Chicken in Minnesota (P. Buesseler, pers. comm.). Forty percent of Gray Partridge nest losses in Michigan were to farm machinery because Alfalfa (*Medicago sativa*) harvest coincided with the nesting peak (Yeatter 1932 *in* Leopold 1933). A third of nests in Saskatchewan tame hay were destroyed by haying but this was all nests active at the time of haying (Pepper 1972).

Extensive research on the effects of haying on the Ring-necked Pheasant (*Phasianus colchicus*) has found hayed forage is less attractive to pheasants than undisturbed vegetation (Kirsh et al. 1978). Pheasants use hay forage mainly for renests (Dumke and Pils 1979). A South Dakota study found wild hay may be more attractive than tame forage (Trautman 1960).

As with waterfowl, reproductive success of upland game birds is higher in undisturbed than hayed tame forage habitat. Ten years of data from Illinois showed 13% of nests in mowed forage hatch while 35% hatch in unharvested forage (Warner and Etter 1989).

Most active nests are destroyed by hay harvesting (Dumke and Pils 1979, George et al. 1979). Pheasant hens are extremely vulnerable to injury and death from mowing equipment. An estimated 65% to 73% of sitting hens are hit by haying equipment (George et al. 1979, Warner and Etter 1989). The majority of hens struck die before the season is over.

Uncut roadsides are very attractive to game birds (Linder et al. 1960). Roadsides cut only once late in the summer are more attractive than ones cut two to three times (Warner et al. 1987). Rights-of-way can be productive especially if left undisturbed (Linder et al. 1960). Delaying harvest also improves productivity (Trautman 1960, Warner et al. 1987). However, predation rates in linear habitats were four times those in non-linear habitats (Haensly et al. 1987).

SHOREBIRDS

Studies of shorebirds on haylands are limited. Haylands and grazed pastures support roughly equal numbers of shorebirds (Kantrud 1981). Upland Sandpipers (*Bartramia longicauda*) definitely preferred areas with residual cover and chose idle grasslands or intermittently mowed road rights-of-way as a nest site much more often than pastures (Higgins et al. 1968). They are definitely vulnerable to mowing because nesting peaks in North Dakota are late June and mid-July (Higgins and Kirsch 1975). All Upland Sandpipers and Killdeer (*Charadrius vociferus*) nesting in unmowed rights-of-way were successful (Oetting and Cassel 1971). Two mower operators in Oregon estimated they killed between 400 and 600 birds, mainly shorebirds, in the period of 1 to 15 July (Braun et al. 1978).

SUGGESTED MANAGEMENT

Solutions proposed in the literature vary depending on land ownership.

Private Land

Since the benefits of delayed cuts have been established it is a desirable practice to see put into place on private lands. The North Dakota Wildlife Extension Program has put this into effect on limited acreage in that state (Stromstad and Donovan 1989). The Prairie CARE (Conservation of Agriculture, Resources and the Environment) program delivered by Ducks Unlimited subscribes farmers in Canada. Prairie CARE pays a fee per acre for hay to be cut only once per year, no earlier than July 15 and restricts other cover removal activities such as grazing and burning. My understanding is that this program is less popular where it would do the most good for wildlife—in areas where early and usually multiple cuts are common.

Several people suggested small tracts of bait cover left near hayfields, whether as a separate block or by leaving blocks of forage at the edge, would increase productivity of game birds (Leopold 1933, Warner and Etter 1989). Placement is important because the majority of game bird nests are found in the field perimeter (Labisky 1957). Early nesters would be attracted to bait cover because it has the most residual vegetation. Birds whose nests are destroyed by haying will be more liable to renest in bait cover than in the hay stubble. Bait cover blocks would take little land out of forage production but may substantially improve wild bird productivity. Leaving uncut blocks or strips could be promoted by wildlife agencies. To be most useful they should be at least several swaths wide and this will probably require subsidies. Encouraging farmers to leave small strips throughout the field would have some wildlife benefits. It should not require an economic incentive since it is sound agricultural practice recommended to forage producers. Strips of residual forage trap snow which insulates plants against winter damage and increases spring moisture which can boost yields by up to 50% (University of Saskatchewan 1987).

Set-aside-programs where government pays farmers to take tracts of land out of production have tremendous benefits for the period they are in force (Warner and Etter 1989). In Canada we have the Permanent Cover Program of Prairie Farm Rehabilitation Administration. It is not a wildlife program and has no restrictions on haying. The addition of wildlife guidelines to the Permanent Cover Programs could benefit nesting birds. The 1985 Food Security Act in the United States authorized a Conservation Reserve Program (CRP) that pays farmers to plant permanent cover on 11 million ha of erodible cropland (Hays et al. 1989). Regular haying is not allowed but widespread emergency haying was authorized during the 1988 drought. Mowing is allowed for weed suppression and during planting, and the majority of farmers surveyed said they mowed their CRP lands (Miller and Bromley 1989). Most allowable mowing occurs during the reproductive stage of pheasants (and most other nesting birds) which diminishes the potential benefit of the permanent cover (Hays et al. 1989, Warner and Etter 1989). A restriction on mowing CRP land would increase avian productivity. North Dakota's Wildlife Extension Program habitat set-aside that pays farmers to idle land was oversubscribed (Stromstad and Donovan 1989).

Other suggestions to modify mowing practices include leaving the middle of fields uncut overnight to allow dispersal of young birds herded into the residual by the mower (Leopold 1933), mowing from the inside to the outside (D. Fraser, pers. comm.), and leaving uncut islands around any nests farmers found. Labisky (1957) recommended large diamond shaped islands. The shape was easier for a farmer to leave and success in large islands of cover was high. Milonski (1958) pointed out it was impractical to expect farmers to leave substantial islands and that you should request what was more likely to be complied with. He asked farmers to leave a few inches around the nest or raise the cutting bar and pass over the nest. Fifty percent of nests in these tiny islands were successful. He felt predators were not particularly inclined to check out a little patch less than a m^2 in size that looked no different from places where the farmer just missed a bit.

If all farmers used recommended haying practices it might increase avian productivity. The Saskatchewan provincial guide suggests harvesting forage with a swather with conditioner attachment is preferable to mowing and raking because fewer leaves are lost (University of Saskatchewan 1987). From a wildlife perspective the swather results in fewer tire tracks and leaves nests between tracks undisturbed while raking is extremely destructive. Most farmers already own a swather and with increasing emphasis on hay quality minimizing leaf loss will be important.

Rights-of-Way

Tremendous benefits would be realized by delayed mowing of roadsides (Trautman 1960). A pilot program established suitable cover in Illinois ditches and obtained 90% farmer cooperation in not cutting ditches until August 1 (Joselyn and Tate 1972). Ditches showed increased pheasant productivity. North Dakota changed its roadside maintenance schedule and protocol and largely followed the recommendations of Oetting and Cassel (1971). They kept snow build-up within acceptable limits by mowing shoulders only. The state realized large cost savings from these changes and increased wildbird production.

In Saskatchewan, Rural Municipalities must mow ditches to collect certain provincial subsidies. The local landowner only has exclusive rights to hay in ditches until July 15. Some wildlife agencies in Canada have unsuccessfully attempted to influence management of this potential wildlife habitat. A restriction on haying prior to July 15 or a change allowing only shoulders to be cut could benefit birds.

Wildlife Lands

There are several options here. No haying at all is one solution (Trautman 1960, Kirsch et al. 1973, Braun et al. 1978, Livezey 1981). Delayed haying is another option that allows some revenue for the area while minimizing losses. However, Strassman (1987) found administrative costs necessary for permits were higher than revenue generated. Some authors feel periodic mowing is necessary to maintain waterfowl productivity levels (Voorhees and Cassel 1980). The amount of delay is a compromise that should be based on the species' peak of nesting and recovery rates of vegetation. Delaying harvest to September might save all nests but leave no time for vegetation recovery and offer little residual to birds the following year. Cutting too late may set plants back. The last option is a rotation haying system where only half the hayland is cut each year (Kirsch 1974).

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LITERATURE CITED

Braun, C.E., K.W. Harmon, J.A. Jackson, and C.D. Littlefield. 1978. Management of National Wildlife Refuges in the United States: its impacts on birds. Conservation Committee report to Wilson Ornithological Society.

Church, K.E. and W.F. Porter. 1990. Winter and spring habitat use by Gray Partridge in New York. J. Wildl. Manage. 54:653-657.

Cowardin, L.M., D.S. Gilmer, and C.W. Shaiffer. 1985. Mallard recruitment in the agricultural environment of North Dakota. Wildl. Monogr. 92:1-37.

Dumke, R.T. and C.M. Pils. 1979. Renesting and dynamics of nest site selection by Wisconsin pheasants. J. Wildl. Manage. 43:705-716.

Elliott, C.R. and R.L. Linder. 1972. Use of state and private lands by pheasants and waterfowl in South Dakota. Am. Midl. Nat. 88:257-261.

Evans, R.D. and C.W. Wolfe, Jr. 1967. Waterfowl production in the rainwater basin area of Nebraska. J. Wildl. Manage. 31:788-794.

Gates, J.M. 1965. Duck nesting and production on Wisconsin farmlands. J. Wildl. Manage. 29:515-523.

George, R.R., A.L. Farris, C.C. Schwartz, D.D. Humburg, and J.C. Coffey. 1979. Native prairie grass pastures as nest cover for upland birds. Wildl. Soc. Bull. 7:4-9.

Haensly, T.F., J.A. Crawford and S.M. Myers. 1987. Relationships of habitat structure to nest success of Ring-necked Pheasants. J.Wildl. Manage. 51:421-425.

Hays, R.L., R.P. Webb, and A.H. Farmer. 1989. Effects of the Conservation Reserve Program on wildlife habitat: results of 1988 monitoring. Trans. N. Am. Wildl. Nat. Res. Conf. 54:365-376.

Higgins, K.F. 1977. Duck nesting in intensively farmed areas of North Dakota. J. Wildl. Manage. 41:232-242.

Higgins, K.F., H.F. Duebbert and R.B. Oetting. 1968. Nesting of the Upland Plover on the Missouri Coteau. Prairie Nat. 1:45-48.

Higgins, K.F. and L.M. Kirsch. 1975. Some aspects of the breeding biology of the Upland Sandpiper in North Dakota. Wilson Bull. 87:96-102.

Joselyn, G.B. and G.I. Tate. 1972. Practical aspects of managing roadside cover for nesting pheasants. J. Wildl. Manage. 36:1-11.

Kantrud, H.A. 1981. Grazing intensity effects on the breeding avifauna of North Dakota native grasslands. Can. Field-Nat. 95:404-417.

Kirsch, L.M. 1974. Habitat Management considerations for prairie chicken. Wildl. Soc. Bull. 2:124-129.

Kirsch, L.M., H.F. Duebbert, and A.D. Kruse. 1978. Grazing and haying effects on habitats of upland nesting birds. Trans. N. Am. Wildl. Nat. Res. Conf. 43:486-497.

Kirsch, L.M., A.T. Klett and H.W. Miller. 1973. Land use and prairie grouse population relationships in North Dakota. J. Wildl. Manage. 37:449-453.

Klett, A.T. and D.H. Johnson. 1982. Variability in nest survival rates and implications to nesting studies. Auk 99:77-87.

Labisky, R.F. 1957. Relation of hay harvesting to duck nesting under a refuge-permittee system. J. Wildl. Manage. 21:194-200.

Leopold, A. 1933. Game management. Charles Scribner's Sons, N.Y., London. 481 pp.

Linder, R.L., D.L. Lyon and C.P. Agee. 1960. An analysis of pheasant nesting in south-central Nebraska. Trans. N. Am. Wildl. Nat. Res. Conf. 25:214-230.

Livezey, B.C. 1981. Duck nesting in retired croplands at Horicon National Wildlife Refuge, Wisconsin. J. Wildl. Manage. 45:27-37.

Miller, H.W. 1971. Relationships of duck nesting success to land use in North and South Dakota. Trans. Int. Congr. Game Biol. 10:133-141. In Higgins 1977.

Miller, E.J. and P.T. Bromley. 1989. Wildlife Management on Conservation Reserve Program Land: the farmers' view. Trans. N. Am. Wildl. Nat. Res. Conf. 54:377-381.

Milonski, M. 1958. The significance of farmland for waterfowl nesting and techniques for reducing losses due to agricultural practices. Trans. N. Am. Wildl. Nat. Res. Conf. 23:215-227.

Oetting, R.B. and J.F. Cassel. 1971. Waterfowl nesting on interstate highway right-of-way in North Dakota. J. Wildl. Manage. 35:774-781.

Page, R.D. and J.F. Cassel. 1971. Waterfowl nesting on a railroad right-of-way in North Dakota. J. Wildl. Manage. 35:544-549.

Pepper, G.W. 1972. The ecology of Sharp-tailed Grouse during spring and summer in the aspen parklands of Saskatchewan. Sask. Dept. Nat. Res. Wildl. Rep. No. 1.

Smith, L.M., J.W. Hupp and J.T. Ratti. 1982. Habitat use and home range of Gray Partridge in eastern South Dakota. J. Wildl. Manage. 46:580-587.

Strassman, B.I. 1987. Effects of cattle grazing and haying on wildlife conservation and National Wildlife Refuges in the U.S. Environ. Manage. 11:35-44.

Stromstad, R.A. and S.P. Donovan. 1989. Wildlife extension: a new face on an old frontier. Trans. N. Am. Wildl. Nat. Res. Conf. 54: 403-408.

Trautman, C.G. 1960. Evaluation of pheasant nesting habitat in eastern South Dakota. Trans. N. Am. Wildl. Nat Res. Conf. 25:202-213.

University of Saskatchewan. 1987. Guide to farm practice in Saskatchewan. U. of S., Division of Extension and Community Relations, Saskatoon.

Voorhees, L.D. and J.F. Cassel. 1980. Highway right-of-way: mowing versus succession as related to duck nesting. J. Wildl. Manage. 44:155-163.

Warner, R.E. and S.L. Etter. 1989. Hay cutting and the survival of pheasants: a long-term perspective. J. Wildl. Manage. 53:455-461.

Warner, R.E., G.B. Joselyn, and S.L. Etter. 1987. Factors affecting roadside nesting by pheasants in Illinois. Wildl. Soc. Bull. 15:221-228.

PRODUCTIVITY OF ENDEMIC GRASSLAND PASSERINES IN HAYLANDS

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INTRODUCTION

Haying of native grassland and tame forage is a widespread agricultural practice and not uncommon on wildlife lands in Canada and the United States. Approximately 3.2 million hectares are sown to forage in the Canadian prairies with 11 million hectares harvested annually in the United States (Driver 1991, Frawley 1989). Cutting of tame forage occurs mainly in June and July, the peak of nesting for many birds. In the United States forage is commonly cut several times—in some places five times. In the Canadian prairies much of the hay is cut only once or twice. Three cuts are typical only with irrigation. No estimate was available for the amount of native grassland cut for hay. Native hay is usually harvested later in summer than tame forage. Studies of the effects of haying on birds, particularly nongame birds, are rarely conducted.

No Sprague's Pipit (*Anthus spragueii*) and very few Baird's Sparrows (*Ammodramus bairdii*) were found in surveys of hayed grasslands in North Dakota (Kantrud 1981). The number of species and individuals using Iowa alfalfa hayfields decreased significantly after mowing (Frawley and Best 1991). Individual species' responses varied but none showed a positive response. Upland nesting Red-winged Blackbirds (*Agelaius phoeniceus*) did not occupy hay habitats until two to four weeks later than old fields with residual vegetation. They deserted hayfields within 48 hours after mowing (Albers 1978).

Early in the century it was noted in Manitoba that native grassland, if hayed, was rendered unsuitable for Baird's Sparrow (Cartwright et al. 1937). More recently in Manitoba, singing bird surveys found Baird's Sparrows to be twice as abundant in idle grassland as hayland (de Smet and Conrad 1991).

Singing bird surveys at Last Mountain Lake, Saskatchewan found that although Savannah Sparrow (*Passerculus sandwichensis*) and Baird's Sparrow and Sprague's Pipit did use annually hayed tame forage, they were significantly less abundant than in undisturbed native areas (Dale 1990, 1991).

An Alberta study documented the negative impact of haying native fescue on bird numbers (Owens and Myres 1973). Baird's Sparrow and Western Meadowlarks (*Sturnella neglecta*) were absent from fescue hayed the previous year and Savannah Sparrow and Sprague's Pipit numbers were considerably reduced when compared to undisturbed fescue. Sprague's Pipit notably did not occupy hayed fescue until some regrowth occurred. It took three to four years for the area to become attractive to Baird's Sparrows (Wershler 1990).

The above studies are based on singing bird surveys which are not always a reliable indictor of a habitat's value to a species (Van Horne 1983). Habitats can attract birds but then fail to provide all the requirements for successful reproduction. Such habitats are termed ecological traps (Gates and Gysel 1978). To fully assess a habitat's value requires some measure of reproductive success.

The intent of this study was to: 1) compare reproductive success of grassland passerines in tame forage and idle native habitats, and 2) to determine if forage harvest affects avian productivity in haylands. Endemic grassland passerines, that have lost vast amounts of their former habitat, were the focus of this investigation. The research was conducted for the Canadian Wildlife Service (CWS) as part of implementing the North American Waterfowl Management Plan (NAWMP) on federal wildlife lands.

METHODS

The study was conducted in the Last Mountain Lake National Wildlife Area, Saskatchewan. Former farmland was seeded to tame forage in the late '60s and early '70s. Until recently it was made available to local farmers to cut for hay after July 1 with the provision

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that they must leave uncut strips. In 1991, the initial date for all cutting was delayed until July 15.

We monitored all nests of non-waterfowl species found by any means in 1990 and 1991. Most nests were discovered by chance when a parent flushed as we passed by while doing other work. Parents carrying food were followed, if possible, and some nests were found that way. A nest was classified as successful if at least one young fledged.

Nests of endemic passerines, particularly Baird's Sparrow, are difficult to find. A more indirect approach was tested in 1990 and applied in 1991. Parental behaviour for many passerines changes after they begin attending young: they carry food to the nest, carry feces away from it, and often change their alarm notes in a recognizable manner. It was therefore, possible to obtain an index of passerine productivity for cut forage and undisturbed native areas by visiting an equal number of plots of each habitat type for a fixed length of time (30 minutes) and recording instances of behaviours associated with brood care.

The index was conservative since one or many instances of brood care behaviour by a species in one field were scored the same. It is an index because we know we are unlikely to detect all productive birds but by spending the same length of time and searching the same area of each habitat we have a measure of productivity which we can compare between habitats. All comparisons were made with Fisher's Exact Test and $p < .05$ was used to establish significance.

RESULTS

Nests

The success rate in native grassland was significantly higher than in hayfields at $p = .10$ in 1990 (Table 1). There was no significant difference between nest success in either cover type in 1991, although the trend was the same as in 1990. The three successful nests in forage were not directly subjected to mowing. The single successful nest in 1990 fledged one day prior to mowing. The two passerine nests that succeeded in forage in 1991 were at field borders that remained unmowed.

Productivity Index

We conducted a preliminary study in 1990 but our methods were not well refined and the results therefore not testahle. The 1990 results led to delaying the date for hay leases to July 15 in 1991 and more consistent sample data. However, in 1990 almost all ohservations indicative of productivity in cut hay were in an unraked field with sizeable uncut patches. Observed parental activity (alarm calls, food carrying, etc.) centred around unmowed portions of the hayfields.

In 1991, prior to baying (July 17 to 29), productivity was higher in native than forage areas for the three most abundant passerines and all species combined but differences were significant only for the latter (Table 2). After forage was cut (July 30 to August 5) the passerine community ("All Species") and Savannah Sparrow and Sprague's Pipit, in particular, were significantly more productive in native cover. The difference between hayfield productivity before and after cutting was significant only for "All Species" and the Savannah Sparrow. As in 1990 parental behaviour of care giving in cut forage was associated with unmown strips.

In summary, hayfields were not as productive for endemic grassland birds as natural habitats. Productivity noticeably declined in hayfield habitats after forage harvest even when haying was delayed to no earlier than July 15. Heavy rains in June 1991 shifted the nesting peak later into the breeding season which partially negated the benefit of delaying harvest until mid-July.

DISCUSSION

These findings are in agreement with the few studies conducted on productivity of nongame birds in harvested forage. Mowing may directly destroy nests or incubating birds. A study of haying and Bobolinks

Table 1. Number of nests in idle native and cut forage at Last Mountain Lake in 1990 and 1991.

	1990		1991	
	Successful	Failed	Successful	Failed
Native	9	2	7	3
Forage	1	4	2	3

Table 2. Number of fields showing productivity in native and forage vegetation before and after mowing at Last Mountain Lake in 1991.

	July 17-29		July 30-August 5	
	Native unmowed (N=12)	Forage before mowing (N=12)	Native unmowed (N=12)	Forage after mowing (N=12)
All species	12	7	11	2
Savannah Sparrow	10	6	7	0
Bairds's Sparrow	2	0	2	2
Sprague's Pipit	2	0	5	0

(*Dolichonyx oryzivorus*) in New York State found 51% of eggs and young in 33 known nests were destroyed during mowing and a further 10% during raking and baling (Bollinger et al. 1990). Mobile young were also vulnerable to the mower. Half of 20 fledglings known to be in the field prior to haying were found dead. In Iowa 100% of above ground nests and 50% of ground nests active at the time of mowing were destroyed (Frawley 1989).

Haying disturbs the parent(s) and removes much of the overhead cover from surviving nests which increases exposure to predators and weather. The New York study found 24% of Bobolink nests in mowed fields were deserted and 9% predated leaving only 6% of the original eggs or young to fledge (Bollinger et al. 1990). It is hard to imagine populations with such low nest success could sustain themselves. The Iowa study estimated productivity for hayfields of from .06 to 2.4 fledglings/territory for six species (Frawley 1989). These rates were well below the 3.3 to 6.7 fledglings necessary for a stable population (ibid.).

Mowing in native grassland may not be as immediately damaging as it is in tame forage but still has an effect. As Owens and Myres (1973) and Wershler (1990) showed in Alberta it may affect the mowed grasslands' attractiveness to birds in the following year or years. Mowing of native cover usually occurs later in the summer so that more birds would have a chance to raise a brood prior to cover removal. In many cases native grass is hayed in a more flexible manner with only the densest portions being harvested and some areas may not be cut every year. Native grasses provide much more dense cover near the ground than does tame forage (number of vegetative contacts in the first decimetre are four to seven times higher in native grass than tame forage). Consequently, there will be more cover to screen the nest from predators and the elements in cut native than cut tame forage. Although he has seen instances of mowing-related nest failure, Ken de Smet feels native hay in Manitoba can be productive in some years (pers. comm.). Recent casual observations of haying in fescue prairie near Little Fish Lake, Alberta show haying is sporadic and patchy. In general the area remains attractive to Baird's Sparrows and they are reasonably productive (C. Wershler, pers. comm.).

Hayfields, especially tame forage, would seem to be an ecological trap for some grassland passerines. Birds are drawn to fast growing cover in spring but productivity is reduced, especially when the nesting peak coincides with forage harvest. Early nesting species may get one brood off before a late June hay cut. Late nesting species may initiate nests and raise young after forage harvest (de Smet and Conrad 1991). The degree to which productivity is impacted by haying is related to local haying schedules, the nesting chronology of species involved, and weather conditions that cause shifts in either factor.

It is hoped that the study results can be applied by land managers to benefit wildlife, specifically endemic grassland birds, which require residual cover to successfully nest.

What can realistically be done to make haying and the welfare of wildbirds (both game and nongame) more compatible? There are two quite different potential areas to influence—private and public lands. There is more private land so changes in productivity, even small ones, are important. No change that causes economic loss to the landowner will be instituted without compensation. Public lands involve a much smaller area but account for most remaining large blocks of native habitat. Good management of them for wildlife is essential and may be easier to obtain so long as economic trade-offs are reasonable. Here are some possibilities.

1. Lobby for continuation of agricultural subsidies that encourage conversion of cropland to tame or native forage (Permanent Cover in Canada, Conservation Reserve Program in the United States). Low wildlife productivity on hayland is preferable to virtually no productivity on cropland. This alone is not enough. We also need to alter harvest conditions to increase avian productivity within haylands. Forage establishment programs are beneficial in terms of soil and water conservation and may take pressure off more critical habitats on public lands which are currently hayed.

2. Alter hay cutting schedules or policies where possible.

a) Wildlife lands - Encourage provincial and federal departments to adopt one of two policies for haying on wildlife lands. These are: defer cutting or don't allow cutting at all.

The majority of United States National Wildlife Refuges currently allow hay cutting prior to July 16 (Strassman 1987). As early as 1978, the Wilson Ornithological Society Conservation Committee (Braun et al. 1978) recommended haying of refuges should be delayed until August 1 to 15. Delaying until early August will increase success of waterfowl and endemic passerines. Frawley (1989) estimated delaying harvest until early August would allow 100% of potential productivity in southern locales. Endemic passerines sometimes nest well into August in Canada but delaying forage harvest further into August in the arid environment of the prairies would allow no time for regrowth and possibly damage plants. The lack of residual vegetation the next spring would make the area unattractive to wildlife or postpone nest initiation.

Where delaying into August will cause unacceptable losses in forage quality, the following compromise may be useful. Fields may be divided in half and the portions cut in alternate years no earlier than mid-July. Cutting half in any given year will provide some benefit through delay to the area cut and prevent losses to mowing in the portion left untouched. This uncut portion would have heavier residual cover in the following spring and attract the earliest nesters who could bring off young prior to cutting in mid-July. The portion cut in the previous year would not become attractive until later in the next breeding season but birds choosing to nest there would be undisturbed.

Strassman (1987) found haying fees charged by United States refuges were well below market price and revenue generated by hay leases did not cover administrative costs. Haying did not perform any habitat regeneration or improvement that could not be done just as well by burning. She admitted that some animals (Horned Larks [*Eremophila alpestris*], longspurs, some shorebirds) do prefer sparse or short vegetation but their habitat needs are met by conventional farmlands.

b) Rights-of-way - Lobby appropriate jurisdictions (i.e., highway departments and municipal governments) for placement of a date restriction on mowing public rights-of-way. In many cases ditches are cut to prevent drifting snow from blocking roads. Delaying the cut until late July would not interfere with this purpose but it might have a significant influence on nest success. In addition, it has been shown cutting only the shoulder is sufficient to prevent snow build up (Oetting and Cassel 1971).

c) Conventional farms - Promote conservation farming methods which include wildlife habitat considerations. Bryan and Best (1991) recommended haying of marginal cover in Iowa should be delayed until late August or even September. Frawley (1989) felt delaying forage harvest until late July would increase nesting success significantly but recognized it was not economically feasible to expect farmers to delay haying until most birds have raised their young. Hay quality declines as summer progresses. The Prairie CARE (Conservation of Agriculture, Resources and the Environment) program, delivered by Ducks Unlimited for the NAWMP, asks for postponement of cutting until July 15. This may be as good a type of compromise as can be expected on conventional farms. Frawley (1989) pointed out new haylands being created under agricultural programs and incentives could potentially have some hay date restrictions placed on them.

Another avenue to increased avian productivity is that wildlife agencies could promote leaving uncut blocks, strips, or patches in hayfields. Blocks or very wide strips may be a good alternative in regions where delayed cuts are unpopular. Strips leave some escape cover for fledglings and increase chances of survival for nests in the strip. Narrow strips also create a snow trap that promotes better soil moisture conservation and increases forage yields. The practice is encouraged by agricultural experts (University of Saskatchewan 1987). Strips near the edge are the most useful for gamebirds since most nests occur there. A qualifier to that is that strips near fencerows are less useful because posts are used by avian predators. The size of strip left greatly influences its usefulness. Narrow strips would trap some snow but provide little habitat and may act as travel lanes for predators. The application of the recommended harvesting technique of using a swather with conditioner (University of Saskatchewan 1987) creates less damage to the nesting environment than mowing and raking.

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LITERATURE CITED

Albers, P.H. 1978. Habitat selection by breeding Red-winged Blackbirds. Wils. Bull. 90:619-634.

Bollinger, E.K., P.B. Bollinger and T.A. Gavin. 1990. Effects of hay-cropping on eastern populations of the Bobolink. Wildl. Soc. Bull. 18:142-150.

Braun, C.E., K.W. Harmon, J.A. Jackson and C.D. Littlefield. 1978. Management of National Wildlife Refuges in the United States: its impacts on birds. Conservation Committee Report to Wilson Ornithological Society.

Bryan, G.G. and L.B. Best. 1991. Bird abundance and species richness in grassed waterways in Iowa rowcrop fields. Am. Midl. Nat. 126:90-102.

Cartwright, B.W., T.M. Shortt and R.D. Harris. 1937. Baird's Sparrow. Trans. of the Royal Canadian Inst. No. 46, Vol. 21, Pt. 2:153-198.

Dale, B. 1990. The effect of haying on grassland passerines at Last Mountain Lake National Wildlife Area - 1989. Unpub. report. Canadian Wildlife Service, Saskatoon. 19 pp., 4 Tables.

Dale, B. 1991. North American Waterfowl Management Plan implementation program related to non-game bird studies within the Prairie Habitat Joint Venture area. Annual Report 1990 - 1991. Unpub. report. Canadian Wildlife Service, Western and Northern Region. 58 pp.

de Smet, K.D. and M.P. Conrad. 1991. Management and research needs for Baird's Sparrows and other grassland species in Manitoba. Pp 83-86 *In*: Proceedings of the Second Endangered Species and Prairie Conservation Workshop. (G.L. Holroyd, G. Burns and H. Smith, eds.) Natural History Occasional Paper No. 15, Provincial Museum of Alberta, Edmonton, Alberta.

Driver, E.A. 1991. Migratory Bird/Agriculture Interactions: Research Needs. Canadian Wildlife Service, Saskatoon. 73 pp.

Frawley, B.J. 1989. The dynamics of nongame bird breeding ecology in Iowa alfalfa fields. M.S. thesis. Iowa State Univ., Ames. 94 pp.

Frawley, B.J. and L.B. Best. 1991. Effects of mowing on breeding bird abundance and species composition in alfalfa fields. Wildl. Soc. Bull. 19: 135-142.

Gates, C.E. and L.W. Gysel. 1978. Avian nest dispersion and fledging success in field-forest ecotones. Ecology 59: 871-883.

Kantrud, H.A. 1981. Grazing intensity effects on the breeding avifauna of North Dakota native grasslands. Can. Field-Nat. 95:404-417.

Oetting, R.B. and J.F. Cassel. 1971. Waterfowl nesting on interstate highway right-of-way in North Dakota. J. Wildl. Manage. 35:774-781.

Owens, R.A. and M.T. Myres. 1973. Effects of agriculture upon populations of native passerine birds of an Alberta fescue grassland. Can. J. Zool. 51:697-713.

Strassman, B.I. 1987. Effects of cattle grazing and haying on wildlife conservation and National Wildlife Refuges in the U.S.. Environ. Manage. 11:35-44.

University of Saskatchewan Division of Extension and Community Relations. 1987. Guide to farm practice in Saskatchewan. Saskatoon.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. J. Wildl. Manage. 47:893-901.

Wershler, C. 1990. Status of the Baird's Sparrow in Alberta - 1989. Unpub. report to World Wildlife Fund Canada. Toronto.

HAYING AND GRASSLAND BIRDS: SUMMATION OF DISCUSSION

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A number of very practical aspects were pointed out by those attending the session. Leaving small strips is not acceptable to farmers using irrigation because the residual cover becomes sodden. An engineer expressed concerns about the ability of unmown ditches to transport water and wondered if leaving blocks at intervals would still help wildlife.

Discussion took place on the topic of quantity versus quality of hay. Where emphasis is on quality then early harvest is necessary and at odds with wildlife benefits. One attendee felt growing emphasis on quality could potentially increase conflict between agriculture and wildlife. Agricultural representatives frequently promote quality hay even where it is inappropriate. If a farmer is raising hay for his own beef animals it is in his best interest to harvest a large quantity of hay later in the season and shifting the emphasis to quality actually costs him money.

The question was raised about whether we should encourage forage production if it is likely to be an ecological trap. It was reemphasized that with management forage could be productive. We can discourage forage production and avoid the trap or we can try and change forage harvest strategies and not only avoid the trap but gain habitat.

A concern was raised that unmowed cover blocks or stretches of ditch may also be a trap because predators work edge habitat. It was restated that productivity gains did vary with ditch width and local predator situations. Widespread program application could result in considerable extra habitat making a predator's task more difficult. An attendee volunteered the information that in Minnesota they are protecting ditch cover and achieving gains in avian productivity. Manitoba is attempting to protect unused rights-of-way.

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GRAZING AND GRASSLAND BIRDS

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A number of studies have demonstrated that various grassland bird species differ in their tolerance to grazing on their breeding grounds. A good overview of the effects of grazing on breeding birds across the northern Great Plains can be found in Kantrud and Kologiski (1982). In the mixed grassland of Alberta (C. Wershler, personal field notes) the following generalized habitat preferences, with respect to grazing intensity, have been noted for the following species: lightly grazed habitats with Baird's Sparrow (*Ammodramus bairdii*), Grasshopper Sparrow (*A. savannarum*), and Sharp-tailed Grouse (*Tympanuchus phasianellus*); lightly to moderately grazed grassland with Sprague's Pipit (*Anthus spragueii*) and Western Meadowlark (*Sturnella neglecta*); moderately grazed grassland with Long-billed Curlew (*Numenius americanus*); moderately to heavily grazed grassland with Chestnut-collared Longspur (*Calcarius ornatus*); heavily grazed grassland with Horned Lark (*Eremophila alpestris*), McCown's Longspur (*Calcarius mccownii*), and Mountain Plover (*Charadrius montanus*). Species that prefer lightly grazed or lightly to moderately grazed habitats also occur in ungrazed grassland. These preferences mostly conform with the findings of Kantrud and Kologiski (1982).

The conservation of species diversity in grassland birds, therefore, requires the maintenance of a range of habitats, from lush grassland in idle or lightly grazed areas to shortgrass conditions in heavily grazed areas. However, all bird species exhibit some degree of variability in their tolerance to grazing, related to the following: differences in soil/vegetation type across the breeding range, climatic fluctuations, and types of grazing systems (differences in duration, frequency, and timing of grazing). For example, light grazing in upland fescue grassland with rich, well-drained soil may result in prime nesting habitat for Baird's Sparrows, while similar grazing in mixed grassland with solonetzic soil may be only marginally productive. In order to develop a strategy for habitat diversity in a particular natural region, it is important to have a basic understanding of the habitat potential for various species in the region and the effects of grazing on the various soils and vegetation types within the region.

In some cases, the management of grazing for a diversity of habitats may actually be detrimental to overall ecosystem diversity. Certain habitat types in specific regions require grazing prescriptions that will create or maintain homogeneous/extreme conditions to maximize productivity for rare and significant ecosystem features. For example, heavy grazing may be required in specific mixed grassland habitats that have high potential for the rare Mountain Plover (Wershler 1991), Richardson's Ground Squirrels (*Spermophilus richardsonii*), and birds of prey; light grazing in these habitats limits their potential for these species. Conversely, no grazing or light, infrequent, late-season grazing is required to maintain lush fescue grassland, an endangered ecosystem. The intensive grazing that occurs in the majority of fescue grassland today severely limits the potential of this habitat for species of birds (e.g., Baird's Sparrow) and plants characteristic of lush fescue grassland (Wershler and Wallis 1990).

Although grassland bird communities evolved with grazing animals, the replacement of the American Bison (*Bison bison*) with cattle, as the dominant grazer, has resulted in habitat changes related to the following:

1. Cattle have different grazing preferences than bison when grazed in the similar habitats for similar periods (Peden et al. 1974, Schwartz and Ellis 1981).

2. Bison grazed over expansive areas of grassland, following traditional seasonal patterns of use. Today's rangelands are, by comparison, very small and are often grazed with the aid of fencing, artificial stock watering areas, salting, and supplemental feeding. In recent decades, there has been a trend in the last remaining tracts of native grassland toward smaller pastures and more intensive management practices.

3. Good range management for domestic livestock production (i.e., maximizing livestock production without adversely affecting range condition) maintains habitat for numerous bird species, but is inadequate for the conservation of the diversity of bird life, including species that require the extremes in range condition (heavily grazed or lush grasslands).

Other changes that have occurred in the grasslands since pre-settlement days, including the suppression of fires and declines in Richardson's Ground Squirrel populations (Wershler 1991), may have had significant impacts on habitats and bird communities. Although, the exact role of fire in Mixed Grassland Ecosystems is not well understood, fire appears to have been a regularly occurring natural phenomenon during dry seasons and drought periods throughout the grasslands of North America (Vogl 1974, Wright and Bailey 1980). Recently burned areas are known to attract grazing animals and certain bird species, including the rare Mountain Plover (Wershler 1991). Fire also results in the re-cycling of nutrients, in seed dispersal for numerous plant species, and in limiting the spread of woody plants.

As with fire, the relationships of Richardson's Ground Squirrels to other components of the mixed grassland have not been well-documented. This species thrives locally in more heavily grazed grassland. As a major food source for Ferruginous Hawks (*Buteo regalis*) and other raptorial birds, ground squirrels must be considered as a key element of the habitat for these predators. In addition, the activities of ground squirrels contribute to ecosystem diversity by providing burrows for numerous species of animals, by influencing vegetative composition, and by providing a valuable food source for predacious mammals and reptiles.

A better understanding of the interrelationships of grazing, fires, and ground squirrel populations, and the role of these factors in the creation and maintenance of biodiversity in the grasslands would provide useful information for the management of birds and other ecosystem components.

MANAGEMENT RECOMMENDATIONS

1. Compared with other animal groups, breeding birds are relatively easy to observe and identify. Surveys of breeding birds in the grasslands can provide a good index of biodiversity and habitat productivity. Utilizing this approach, research should be carried out into the effects of various grazing systems on populations of grassland birds. This should include: 1) research in representative major habitats of the various natural regions so that appropriate range management guidelines can be developed for a given ecotype, and 2) work in specific areas (e.g., protected areas) to monitor the effectiveness of prescribed management.

2. Ideally, this research should involve the long-term monitoring of the relative abundance and composition of bird populations—this would provide valuable insight into natural population variability, which would be of value in the application and assessment of management strategies.

3. Although management practices for the maintenance of avian diversity will generally benefit other groups of animals and plants, studies specific to these groups are needed in order to identify the range of management requirements for the conservation of their biodiversity.

4. These types of studies should be initiated on Crown lands (e.g., protected areas, grazing reserves) and special management areas where the largest remnants of relatively undisturbed native grassland generally exist, and where there is often a clear mandate for the maintenance of biodiversity.

5. Investigations should be undertaken on bison versus cattle grazing, the role of fire, and the role and status of ground squirrels in the grassland ecosystem.

6. Significant ecosystem components (e.g., major ground squirrel-raptor associations) and critical habitats for rare species should be identified and management strategies developed to optimize the potential of these special areas.

LITERATURE CITED

Kantrud, H.A. and R.L. Kologiski. 1982. Effects of soils and grazing on breeding birds on uncultivated upland grasslands of the Northern Great Plains. U.S. Department of the Interior, Fish and Wildlife Service Wildlife Resource Report 15.

Peden, D.G., G.M. Van Dyne, R.W. Rice, and R.M. Hansen. 1974. The trophic ecology of *Bison bison* on shortgrass plains. Journal of Applied Ecology 11:489-498.

Schwartz, C.C. and J.E. Ellis. 1981. Feeding ecology and niche separation in some native and domestic ungulates on the shortgrass prairie. Journal of Applied Ecology 18:343-353.

Vogl, R.J. 1974. Effects of fire on grasslands. Pp. 139-194 *In*: Fire and ecosystems (Kozlowski, T.T. and C.E. Ahlgren, eds.), Academic Press, New York.

Wershler, C.R. 1991. A management strategy for Mountain Plovers in Alberta. Pp. 169-172 *In*: Proceedings of the second endangered species and prairie conservation workshop (Holroyd, G.L., G. Burns, and H.C. Smith eds.). Natural History Occasional Paper No. 15. Provincial Museum of Alberta, Edmonton, Alberta.

Wershler, C.R. and C.A. Wallis. 1990. Survey and evaluation of northern fescue grassland in Alberta - 1989. Prepared by Sweetgrass Consultants Ltd. for Alberta Forestry, Lands and Wildlife, Edmonton.

Wright, H.A. and A.W. Bailey. 1980. Fire ecology and prescribed burning in the Great Plains - a research review. General Technical Report INT-77, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah.

GRASSLAND REQUIREMENTS BY FERRUGINOUS HAWKS

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As its distribution on the great plains of North America attests, the Ferruginous Hawk (*Buteo regalis*) is an open country raptor. Below is a summary of observations which describe this hawk's response to changes in habitat, changes in prey densities, and potential competition with other raptors. I will focus the discussion on populations inhabiting the broadly classified "grassland" ecosystem east of the Rocky Mountains. Populations west of the Rocky Mountains may have different ecological requirements (Schmutz and Fyfe 1987, Schmutz et al. 1990).

HABITAT

Since settlement of the Canadian prairies, two major changes in habitat have occurred: the expansion of parkland into prairie habitat and the cultivation of interspersed grassland. Both have affected Ferruginous Hawks negatively.

The departure on the part of Ferruginous Hawks from approximately 50% of their former breeding range in Canada correlates with an expansion of trees from the adjacent parkland. While Ferruginous Hawks prefer elevated sites including trees for nesting (Schmutz et al. 1988), the hawks are uncommon in extensively treed areas. The expansion of parkland habitat following a reduction in prairie fires after settlement (Vogl 1974) has permitted Red-tailed (*Buteo jamaicensis*; Houston and Bechard 1983) and Swainson's Hawks (*B. swainsoni*) to expand into areas formerly occupied by Ferruginous Hawks.

A link between breeding density of Ferruginous Hawks and grassland has long been demonstrated (see Schmutz 1984, for additional references). However, agricultural cultivation has not been detrimental to Ferruginous Hawks in all cases. A study of Ferruginous Hawk breeding density on 76 randomly selected 41 km^2 study plots in southeastern Alberta in 1982 and 1987, showed a statistically significant increase in breeding density when plots with 0-10% cultivation were compared with plots between 11-30% cultivation (Schmutz 1989). However, when the extent of cultivation exceeded 50%, breeding density declined steadily.

PREY USE

The initial increase and subsequent decline by Ferruginous Hawks in response to increased cultivation on plots was probably mediated by Richardson's Ground Squirrels (*Spermophilus richardsonii*). Ground squirrel abundance in relation to cultivation showed a pattern similar to Ferruginous Hawk abundance (Schmutz 1989). This link between predator and prey is consistent with evidence that showed a close correlation between ground squirrel and Ferruginous Hawk abundance over a 9-year period on a study area near Hanna, Alberta (Schmutz and Hungle 1989). More ground squirrels also led to more young Ferruginous Hawks being raised to fledging.

Interestingly, the density of Ferruginous Hawks wintering in northwestern Texas was not correlated with the extent of cultivation. Ferruginous Hawks there apparently relied on Black-tailed Prairie Dogs (*Cynomys ludovicianus*; Schmutz 1987, Schmutz and Fyfe 1987), as they do in some other areas (Cully 1991, Treviño-Villareal 1990). Due to their colonial nature, many prairie dogs often frequented small parcels of uncultivated land where the prairie dogs were able to persist in otherwise extensively cultivated regions despite eradication campaigns. These and the results obtained in Alberta suggest that it is not agricultural cultivation per se that affects Ferruginous Hawks negatively. Instead, cultivation lowers prey densities and thereby causes a decline in the abundance of Ferruginous Hawks.

Although other buteonine hawks have ecological requirements similar to Ferruginous Hawks, these, notably Swainson's Hawks, did not decline as more land was cultivated (Schmutz 1989). Swainson's and Red-tailed Hawks were apparently able to shift to other prey after ground squirrels disappeared in extensively cultivated regions. Ferruginous Hawks in contrast appear to be ground squirrel specialists and are hence vulnerable to changes in habitat and prey abundance.

COMPETITION

In some cases where Ferruginous Hawks have nested in close proximity to other buteos, Ferruginous Hawks have come into conflict. The aggressive Swainson's Hawks have attacked (Restani 1991) and sometimes evicted Ferruginous Hawks (Schmutz et al. 1980) from their nests when nest sites where in short supply. However, if competition for space existed in some instances this did not appear to affect Ferruginous Hawk distribution overall. Based on 76 study plots in Alberta, there was no evidence that Ferruginous Hawks were low in numbers when Swainson's Hawk were abundant (Schmutz 1989).

RECOMMENDATIONS

Ferruginous Hawk's are remarkably flexible in their choice of nest sites using trees or ground sites where possible as availability dictates. However, the Ferruginous Hawk's dependence on grassland and the ground squirrels and prairie dogs that exist there, has important implications for this species' conservation. Because of their adaptation for the arid prairie environment, Ferruginous Hawks are able to cope with the normal fluctuations in ground squirrel abundance, and with heat and hail. However, these same specializations make this species vulnerable to changes.

Ferruginous Hawks are generally common where a ranching land use prevails. The low level cultivation that is practised by ranchers presents little if any problem and ground squirrels are generally tolerated in rangeland. As long as this type of land use persists on the breeding ground in Canada, along the migration pathway and in the wintering area, there is considerable assurance that Ferruginous Hawks will grace the Canadian prairies for many years to come.

LITERATURE CITED

Cully, Jr., J.F. 1991. Response of raptors to reduction of a Gunnison's Prairie Dog population by plaque. Am. Midl. Nat. 125:140-149.

Houston, C.S. and M.J. Bechard. 1983. Trees and the Red-tailed Hawk in southern Saskatchewan. Blue Jay 14:99-109.

Restani, M. 1991. Resource partitioning among three *Buteo* species in the Centennial Valley, Montana. Condor 93:1007-1010.

Schmutz, J.R. 1984. Ferruginous and Swainson's Hawk abundance in relation to land use in southeastern Alberta. J. Wildl. Manage. 48:1180-1187.

Schmutz, J.R. 1987. Population size, distribution and survival of Ferruginous Hawks in northwest Texas. Upubl. report. Dept. of Biology, University of Saskatchewan.

Schmutz, J.R. 1989. Hawk occupancy of disturbed grasslands in relation to models of habitat selection. Condor 91:362-371.

Schmutz, J.R., S. Brechtel, R.D. De Smet, D.G. Hjertaas. G.L. Holroyd and C.S. Houston. 1990. Recovery plan for the Ferruginous Hawk in Canada. Prepared for the Committee for the Recovery of Nationally Endangered Wildlife (RENEW).

Schmutz, J.R. and R.W. Fyfe. 1987. Migration and mortality of Alberta Ferruginous Hawks. Condor 89:169-174.

Schmutz, J.K. and D.J. Hungle. 1989. Populations of Ferruginous and Swainson's Hawks increase in synchrony with ground squirrels. Can. J. Zool. 67:2596-2601.

Schmutz, J.R., S.M. Schmutz and D.A. Boag. 1980. Coexistence of three species of hawks (*Buteo* sp.) in the prairie-parkland ecotone. Can. J. Zool. 58:1075-1089.

Schmutz, J.R., W.D. Wishart, J. Allen, R. Bjorge and D.A. Moore. 1988. Dual use of nest platforms by hawks and Canada Geese. Wildl. Soc. Bull. 16:141-145.

Treviño-Villareal, J. 1990. The annual cycle of the Mexican prairie dog. Occasional Paper No. 139, Museum of Natural History, University of Kansas, Lawrence, Kansas.

Vogl, R.J. 1974. Effects of fire on grasslands. Pp. 108-152 *In*: Physiological Ecology. (T.T. Rozlowski, ed.). Academic Press, New York.

TOXICOLOGY OF PESTICIDES IN PRAIRIE CANADA: PROGRESS AND FUTURE DIRECTIONS

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Canada has an impressive record of risk assessment and investigation into the effects of agricultural pesticides on prairie flora and fauna. This review covers most of the work that has been done relative to environmental effects in this region, but it barely touches on the important subject of environmental chemistry (partitioning and degradation), for which a large body of information exists, at least for aquatic systems, due to the excellent research program of the Freshwater Institute in Winnipeg. Recommendations for further work include action items resulting from the discussions that followed the three papers presented in the toxicology session, published in these proceedings, and priorities identified by several working groups of environmental toxicologists and chemists.

CURRENT INFORMATION

Potential effects of pesticides on waterfowl have constituted the topic of greatest concern for the past 10 years. All currently available data were very thoroughly reviewed by the Canadian Wildlife Service (CWS) to evaluate the degree of overlap between waterfowl habitat and crop production, the extent of pesticide use for various types of crops, and the potential effects of herbicides on terrestrial and aquatic vegetation and invertebrates, and of insecticides on waterfowl and their invertebrate food resource (Sheehan et al. 1987). These concerns have been summarized (Mineau et al. 1987) and updated (Forsyth 1989, 1991). Studies of the toxicity of carbofuran (Furadan) insecticide to Mallard ducklings (*Anas platyrhynchos*) have shown that daily dosing with sublethal but relatively high doses caused delayed fledging (Martin et al. 1991a). Single sublethal doses impaired thermoregulatory ability (Martin and Solomon 1991) and walking 150 m through carbofuran-sprayed vegetation was not lethal, but caused signs of intoxication and inhibition of approach-response behavior towards other ducklings (Martin et al. 1991b). Further studies of the impact of carbofuran-sprayed vegetation on ducklings showed that effects were negligible unless feeding on sprayed material occurred during the walk with a hen duck (Martin and Forsyth, in press). Carbofuran sprayed on prairie ponds to simulate aerial application for grasshopper control resulted in significant mortality of caged aquatic invertebrates (Wayland and Boag 1990) and over 90% loss of Freshwater Shrimp (*Hyalella azteca*) biomass, and 83% loss of chironomid larvae biomass (Wayland 1991).

The synthetic pyrethroid insecticides, permethrin, cypermethrin, deltamethrin, and fenvalerate, are highly toxic to aquatic invertebrates; hence, their persistence and effects in prairie ponds are of concern due to the likelihood of direct application to ponds by aircraft spraying of crops. Deltamethrin (Decis®) degrades rapidly in water, and is partitioned into organic matter; intact deltamethrin remained at 3-5 ng/g in sediment 305 days after treatment of small research ponds with acetone solutions of insecticide (Muir et al. 1985a). It should be noted, however, that deltamethrin persistence in sediment was not found in ponds sprayed by aircraft, probably due to the concentration of material in the surface layer of water, followed by volatilization (Muir et al. 1992). Aerial application of deltamethrin to prairie ponds at the rate used on crops resulted in a 99% kill of chironomid larvae, and Mallard ducklings on the treated ponds stopped gaining weight and some died, whereas growth of control ducklings was unimpeded (Morrill and Neal 1990). Chironomid larvae concentrated pyrethroids during 24 hours of exposure to sediments containing 5 ng/g without apparent harmful effects (Muir et al. 1985b). Whether or not longer periods of exposure might have proven harmful has not been determined. Laboratory studies with permethrin demonstrated that sediment contaminated by application to water at the rate registered for insect control caused 100% mortality of mayfly nymphs (*Hexagenia rigida*), eight days after application (Friesen et al. 1983).

Effects of herbicides in prairie ponds have received very little study. Productivity of periphytic algae in marsh enclosures was reduced 90% by addition of terbutryn to the water at 0.01 mg/l, but was not affected by simazine at 0.1 mg/l (Goldsborough and Robinson 1983). Spray application of bromoxynil esters (Torch DS formulation) to the surface of experimental ponds at the Delta marsh in Manitoba resulted in mortality of caged Brook Stickleback (*Culaea inconstans*) and

Freshwater Shrimp when concentrations in the water were at least 2.1-5.8 μg/L and 35-64 μg/L, respectively. Resident populations of Freshwater Shrimp did not exhibit mortality, however, whereas resident sticklebacks disappeared (Muir et al. 1991). Submerged macrophytes in pond enclosures exhibited a dose-dependent response in growth and survival when 2,4-D, picloram or clopyralid was added to the water in concentrations of 0.01 or 0.1 mg/litre (Forsyth et al., in press). A study of the effect of glyphosate (Roundup formulation) on productivity of phytoplankton in ponds has been completed by the Inland Waters Directorate, Environment Canada, Regina (P. Shaw), and the uptake and effects of triallate in *H. azteca* are being investigated by the National Hydrology Research Institute (M. Arts).

Application of glyphosate (Roundup®) or sethoxydim (Poast®) to the eggs of domestic chickens did not reduce hatchability, indicating that the use of these herbicides in zero tillage farming should not be hazardous to the eggs of upland-nesting galliforms or waterfowl (Batt et al. 1980, Wayland et al. 1987). The insecticides, carbofuran, chlorpyrifos, and deltamethrin, were similarly low in toxicity to Japanese Quail eggs (*Coturnix japonica*); however, further testing may be required on eggs of more sensitive species (Martin 1990). Japanese Quail, Ring-necked Pheasant (*Phasianus colchicus*), and Savannah Sparrow (*Passerculus sandwichensis*) provided with dimethoate-treated bran bait scattered on cage floors at the rate used for grasshopper control did not undergo measurable depression of brain cholinesterase after 24 hours of exposure (Radvanyi et al. 1986). Direct overspraying of Burrowing Owl (*Athene cunicularia*) nest burrows with carbofuran for grasshopper control resulted in reductions of 83% in brood size and 82% in nest success, whereas carbaryl (Sevin®) and chlorpyrifos (Lorsban®) had no effect (Fox et al. 1989). Penned pheasant chicks, seven weeks old, exposed for five days to scattered grain sprayed on the first day with carbofuran at the rate used for grasshopper control were not adversely affected (Somers et al. 1991a). Similarly, pheasant and Chukar (*Alectoris chukar*) chicks four days old were not affected in weight gain or brain cholinesterase activity by direct spray application of carbofuran, carbaryl, or dimethoate (Somers et al. 1991b). Carbofuran applied by aircraft at the rate of 140 g active ingredient per hectare to a square mile of pasture in Saskatchewan resulted in no discernible effects on small mammal abundance and did not cause signs of overt toxicity in songbirds, although brain cholinesterase activity was significantly depressed and fledging success was almost 40% less than that of birds in a control pasture (Irvine 1987). Availability to wildlife of carbofuran in vegetation and grasshoppers was also documented (Forsyth and Westcott, manuscript submitted). Captive Clay-colored Sparrows (*Spizella pallida*) demonstrated a preference for dead over live grasshoppers in prey selection trials, and were not made sick by eating grasshoppers sprayed at the rate used in the field as their sole source of food for one day (Forsyth et al., manuscript submitted). Granular carbofuran is highly toxic to songbirds, is commonly deposited on the surface of soil during seeding, and was the cause of one very large kill of migrating Lapland Longspurs (*Calcarius lapponicus*) documented in Saskatchewan (Mineau 1988). Preliminary results of the Prairie Nestbox Monitoring Program (Horstman et al., this volume), indicate that some insecticides may be causing abandonment of nests by Mountain Bluebirds (*Sialia currucoides*) and Tree Swallows (*Tachycineta bicolor*). Survival, measured as trappability of tagged young Deer Mice (*Peromyscus maniculatus*) and Meadow Voles (*Microtus pennsylvanicus*) of all ages in grassland sprayed with carbofuran for grasshopper control was 40% and 33%, respectively, less than that of unsprayed populations (Brusnyk and Westworth 1987).

American Kestrels (*Falco sparverius*) fed one chlorophacinone-killed mouse per day for 21 days behaved normally and survived the treatment, although haemorrhaging was evident. The authors concluded that wild kestrels might suffer lethal effects of this rodenticide if they ate more than one poisoned mouse per day for more than 21 days (Radvanyi et al. 1988). Nestling Swainson's Hawk (*Buteo swainsoni*) that consumed ground squirrels poisoned by strychnine, but with stomachs removed to eliminate poisoned grain, did not exhibit adverse effects on growth or survival (Schmutz et al. 1989). Reproduction and survival of Burrowing Owls were also not affected by Strychnine poisoning of ground squirrels in the close vicinity of nest burrows (James et al. 1990).

INTEGRATION OF AGRICULTURE AND WILDLIFE

Attainment of the goal of sustainable crop production that conserves wildlife populations within the agricultural landscape requires improved understanding of the effects of pesticides in ecosystems and communication of information to farmers. The discussion following the toxicology session generated two very relevant action items: (a) Multidisciplinary controlled field studies at the ecosystem level should be undertaken to determine the fate and effects of major-use pesticides in terrestrial and aquatic systems, and (b) Information on the environmental hazards of, and alternatives to, pesticides, should be provided to farmers to facilitate their modification of traditional approaches to production. The first of these recommendations is also a stated objective of the Canadian Network of Toxicology Centres, supported by the Green Plan of the Government of Canada. Therefore, efforts will be made to focus the expertise available in the prairie region and elsewhere in Canada on field studies designed to establish how various organisms are exposed, the extent of effects on behavior, reproduction and survival, and methods for extrapolating from laboratory studies to the field. The second recommendation will be addressed by a series of pamphlets, currently being prepared by the CWS, which will outline hazards of pesticides to wildlife for farmers and will further be addressed by the Pest Management Alternatives Office, a 1992 Green Plan initiative of the federal government, that will promote alternatives to chemical pesticides, stimulate and fund research, and maintain a computerized information base.

Some of the priorities for research identified by working groups of a workshop sponsored by the Society of Environmental Toxicology and Chemistry are: field validation of risk assessment procedures, development of ecologically significant endpoints for effects assessment, bioavailability of chemicals from sediments, prediction of ecosystem stress from controlled laboratory and field investigations, sublethal effects of chemicals in aquatic organisms, factors affecting exposure of terrestrial organisms to toxins, identification of sentinel species, influence of sensory detection on exposure, comparative biochemistry and physiology, behavioral toxicology, and effects at the population, community, and ecosystem levels. The Avian Effects Dialogue Group identified needs for selection of potential focal (sentinel) species of bird in various crop areas, development of pesticide sensitivity data for focal species in the laboratory, testing their response to pesticides in the field, establishment of a network of field reporters from various segments of society to monitor incidents of pesticide poisoning of birds, and development of models to predict effects of pesticides on birds. These lists are only partial; for additional priorities and details of the rationale for each, see Anonymous (1987, 1991).

The foregoing action items and priorities are consistent with the data gaps identified by Sheehan et al. (1987) and with the ongoing program of research and monitoring of the CWS and collaborating scientists. Initiatives are underway to assess pesticide effects and benefits of alternative agricultural practices by comparing avifaunal diversity and abundance on organic versus conventional farms (Rogers and Freemark 1991) and establishing long-term multidisciplinary studies of wildlife-agriculture interactions with cooperating landowners. Similar projects in Britain (Jarvis 1988), Denmark (Brae and Petersen 1988) and the Netherlands (deSnoo and Canters 1988) will serve as models.

LITERATURE CITED

Anonymous. 1987. Research priorities in environmental risk assessment. Workshop report (Fava, J.A., W.J. Adams, R.J. Larson, G.W. Dickson, K.L. Dickson and W.E. Bishop, eds.), Society of Environmental Toxicology and Chemistry, Pensacola, Florida.

Anonymous. 1991. Assessing pesticide impacts on birds: Discussions of the Avian Effects Dialogue Group (1989-1991). Resolve, World Wildlife Fund, Washington, D.C.

Batt, B.D.J., J.A. Black and W.F. Cowan. 1980. The effects of glyphosate herbicide on chicken egg hatchability. Canadian Journal of Zoology 58:1940-1942.

Brae, L.H. and B.S. Petersen. 1988. Bird fauna in organically and conventionally farmed areas: a comparative study of bird fauna and the effects of pesticides. Ministry of the Environment, Silkeborg, Denmark.

Brusnyk, L.M. and D.A Westworth. 1987. Effects of carbofuran on unconfined small mammal populations in southern Alberta. D.A. Westworth and Associates Ltd., Unpublished report to Alberta Agriculture, Edmonton.

deSnoo, G.R. and K.J. Canters. 1988. Side effects of pesticides on terrestrial vertebrates. CML Report 35. Centre for Environmental Studies, Leiden University, The Netherlands. English Translation.

Forsyth, D.J. 1989. Agricultural chemicals and prairie pothole wetlands: meeting the needs of the resource and the farmer - Canadian perspective.

Transactions of the North American Wildlife and Natural Resources Conference 54:59-66.

Forsyth, D.J. 1991. Pesticides and wildlife. Pp. 23-25 *In:* Proceedings of the Second Endangered Species and Prairie Conservation Workshop (G.L. Holroyd, G. Burns and H.C. Smith, eds.), Provincial Museum of Alberta, Natural History Occasional Paper No. 15.

Forsyth, D.J., C.F. Hinks and N.D. Wescott. Consumption rates and toxicity of live, dead and carbofuran-sprayed grasshoppers in prairie sparrows. Environmental Toxicology and Chemistry. Manuscript submitted.

Forsyth, D.J. and N.D. Westcott. Carbofuran residues in grasshoppers and vegetation from aerially sprayed prairie pastures: potential effects on wildlife. Environmental Toxicology and Chemistry. Manuscript submitted.

Forsyth, D.J., G.G. Shaw and P.A. Martin. Effects of herbicides on two submerged aquatic macrophytes, *Potomogeton pectinatus* and *Myriophyllum sibiricum* in a prairie wetland. Environmental Pollution. In press.

Fox, G.A., P. Mineau, B. Collins and P.C. James. 1989. The impact of the insecticide carbofuran (Furadan 480F) on the burrowing owl in Canada. Technical Report Series No. 72. Canadian Wildlife Service, Ottawa.

Friesen, M.K., T.D. Galloway and J.F. Flannagan. 1983. Toxicity of the insecticide permethrin in water and sediment to nymphs of the burrowing mayfly *Hexagenia rigida* (Ephemeroptera: Ephemeridae). Canadian Entomologist 115:1007-1014.

Goldsborough, L.G. and G.G.C. Robinson. 1983. The effect of two triazine herbicides on the productivity of freshwater marsh periphyton. Aquatic Toxicology 4:95-112.

Irvine, D.G. 1987. Effects of grasshopper insecticides upon valuable wildlife. Progress report to World Wildlife Fund, Toronto.

James, P.C., G.A. Fox and T.J. Ethier. 1990. Is the operational use of strychnine to control ground squirrels detrimental to Burrowing Owls? Journal of Raptor Research 24:120-123.

Jarvis, R.H. 1988. The Boxworth project. Pp. 46-55 *In:* Britain Since Silent Spring (D.J.L. Harding, ed.). Institute of Biology, London, England.

Martin, P.A. 1990. Effects of carbofuran, chlorpyrifos and deltamethrin on hatchability, deformity, chick size and incubation time of Japanese quail (*Coturnix japonica*) eggs. Environmental Toxicology and Chemistry 9:529-534.

Martin, P.A. and D.J. Forsyth. Survival and behaviour of mallard duck broods exposed to carbofuran-sprayed vegetation: a field experiment. Ecotoxicology. In press.

Martin, P.A. and K.R. Solomon. 1991. Acute carbofuran exposure and cold stress: interactive effects in mallard ducklings. Pesticide Biochemistry and Physiology 40:117-127.

Martin, P.A., K.R. Solomon and H.J. Boermans. 1991a. Effects of carbofuran ingestion on mallard ducklings. Journal of Wildlife Management 55:103-111.

Martin, P.A., K.R. Solomon, D.J. Forsyth, H.J. Boermans and N.D. Westcott. 1991b. Effects of exposure to carbofuran-sprayed vegetation on the behavior, cholinesterase activity and growth of mallard ducklings (*Anas platyrhynchos*). Environmental Toxicology and Chemistry 10:901-909.

Mineau, P. 1988. Avian mortality in agro-ecosystems. 1. The case against granular insecticides in Canada. Pp. 3-12 *In*: Environmental effects of pesticides (M.P. Greaves, B.D. Smith, and P.W. Greig-Smith, eds.), British Crop Protection Council Monograph No. 40. BCPC Publications, Thornton Heath, England.

Mineau, P., P.J. Sheehan and A. Baril. 1987. Pesticides and waterfowl on the Canadian prairies: a pressing need for research and monitoring. Pp. 133-147 *In:* The value of birds (A.W. Diamond and F.L. Filion, eds.). ICBP Technical Publication No. 6.

Morrill, P.K. and B.R. Neal. 1990. Impact of deltamethrin insecticide on Chironomidae (Diptera) of prairie ponds. Canadian Journal of Zoology 68:289-296.

Muir, D.C.G., G.P. Rawn and N.P. Grift. 1985a. Fate of the pyrethroid insecticide deltamethrin in small ponds: a mass balance study. Journal of Agricultural and Food Chemistry 33:603-609.

Muir, D.C.G., G.P. Rawn, B.E. Townsend, W.L. Lockhart and R. Greenhalgh. 1985b. Bioconcentration of cypermethrin, deltamethrin, fenvalerate and permethrin by *Chironomus tentans* larvae in sediment and water. Environmental Toxicology and Chemistry 4:51-61.

Muir, D.C.G., D.F. Kenny, N.P. Grift, R.D. Robinson, R.D. Titman and H.R. Murkin. 1991. Fate and acute toxicity of bromoxynil esters in an experimental prairie wetland. Environmental Toxicology and Chemistry 10:395-406.

Muir, D.C.G., A.L. Yarechewski and B.R. Neal. 1992. Influence of surface films on the fate of deltamethrin following aerial application to prairie ponds. Environmental Toxicology and Chemistry 11:581-591.

Radvanyi, A., P. Kroeger, D.G. Bushy and G.G. Shaw. 1986. Responses of quail, pheasants, and sparrows to one oral dose of dimethoate and to consumption of dimethoate treated bran baits. Bulletin of Environmental Contamination and Toxicology 36:616-621.

Radvanyi, A., P. Weaver, C. Massari, D. Bird and E. Broughton. 1988. Effects of chlorophacinone on captive kestrels. Bulletin of Environmental Contamination and Toxicology 41:441-448.

Rogers, C.A. and K.E. Freemark. 1991. A feasibility study comparing birds from organic and conventional (chemical) farms in Canada. Technical Report Series No. 137. Canadian Wildlife Service, Environment Canada, Ottawa.

Schmutz, J.F., K.A. Rose and R.G. Johnson. 1989. Hazards to raptors from strychnine poisoned ground squirrels. Journal of Raptor Research 23:147-151.

Sheehan, P.K., A. Baril, P. Mineau, D.K. Smith, A. Harfenist and W.K. Marshall. 1987. The impact of pesticides on the ecology of prairie-nesting ducks. Technical Report Series No. 19. Canadian Wildlife Service, Ottawa.

Somers, J.D., M.W. Barrett and A.A. Khan. 1991a. Simulated field ingestion of carbofuran-contaminated feedstuffs by pheasants. Bulletin of Contamination and Toxicology 47:521-528.

Somers, J.D., A.A. Khan, Y. Kumar and M.W. Barrett. 1991b. Effects of simulated field spraying of carbofuran, carbaryl and dimethoate on pheasant and partridge chicks. Bulletin of Environmental Contamination and Toxicology 46:113-119.

Wayland, M. 1991. Effect of carbofuran on selected macroinvertebrates in a prairie parkland pond: an enclosure approach. Archives of Environmental Contamination and Toxicology 21:270-280.

Wayland, M., B.D.J. Batt and W.F. Cowan. 1987. The effects of two postemergence herbicides on hatchability of chicken eggs. Canadian Journal of Zoology 65:1860-1861.

Wayland, M. and D.A. Boag. 1990. Toxicity of carbofuran to selected macroinvertebrates in prairie ponds. Bulletin of Environmental Contamination and Toxicology 45:74-81.

PESTICIDES AND WILDLIFE IN THE PRAIRIES: CURRENT REGULATORY ISSUES

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INTRODUCTION

The agricultural landscape of the Canadian prairies covers most of the southern third of Alberta, Saskatchewan and Manitoba. Within this large area of extensive agriculture are found remnants of wildlife habitat dispersed within and around cultivated fields. These habitats consist of woodlots, shelterbelts, ditches, coulees, isolated plots of grassland, and wetlands, all essential to the maintenance of healthy wildlife populations in the prairies. This region is also known for the extensive use of farm chemicals which can pose a serious threat to this resource. Sales of insecticides and herbicides in the three prairie provinces accounted for 48% and 67% respectively of total Canadian sales in 1986 (Environment Canada/Agriculture Canada 1987).

Because of this extensive overlap between wildlife habitat and agrochemical use, the Canadian Wildlife Service (CWS), as an advisor to Agriculture Canada (AC) on the effects of pesticides on wildlife, has focused much of its attention on this region. As a participant in the pesticide regulatory process, CWS has an input to the regulatory decisions which can encompass approval or denial of new registrations, modification of labels, use restrictions or even cancellation of existing registrations. To illustrate part of the process of evaluation of the impact of pesticides on wildlife, three issues of concern to CWS are discussed. The focus of the discussions are on the origin of the concern, the studies conducted to determine the extent of the risk, and finally, the regulatory actions which were taken or have been proposed.

THE BURROWING OWL

The Burrowing Owl (*Athene cunicularia*) is a small owl of the western prairies and British Columbia interior which nests in abandoned mammal burrows and which feeds extensively on small mammals, grasshoppers and other insects. The Canadian population of Burrowing Owl has undergoue a sharp decline in the last 20 years (Fox et al. 1989). Between 1976 and 1987, the number of breeding pairs in South-central Saskatchewan fell by 50%; in Manitoba, numbers fell from 76 pairs in 1982 to 15 in 1987. In 1979 the Burrowing Owl was designated as a threatened species by COSEWIC (Committee on the Status of Endangered Wildlife in Canada).

Evidence had indicated that in three districts in Alberta owls had not been seen since most farms were sprayed with insecticides to control severe grasshopper infestations in 1974 and 1975 (Wedgwood 1978). In 1985 approximately 3 million hectares were sprayed in Saskatchewan to control grasshoppers, 40% of which was carried out using carbofuran, an insecticide extremely toxic to birds. Because much of the preferred habitat of the owls coincides with cropland cultivated for cereal and forage, the CWS commissioned a study of the impact of grasshopper insecticide sprays on this threatened species.

The impact of operational grasshopper control on Burrowing Owls was studied in 1986 and 1987 at three sites in Saskatchewan (Fox et al. 1989). The studies showed that carbofuran had a significant impact on the survival and the reproductive success of the owls when sprayed over the nest burrows: brood size and nesting success were reduced respectively by 83% and 82% when compared to a control group. Secondly, reproductive success decreased with increasing proximity of the exposure to the burrow. Furthermore, a survey of landowners on the study areas suggested that the number of active nests in 1987 was significantly smaller on lands which had been sprayed for grasshoppers with carbofuran in 1985 or 1986 than on lands sprayed with other insecticides during the same period. The authors of the study concluded that the impact of carbofuran was a result of its toxicity rather than food removal and that, in spite of few data, at least two other insecticides, carbaryl and deltamethrin, did not cause similar effects.

Subsequent to this study, Environment Canada (EC) recommended to AC that extensive geographic restrictions be put on the use of carbofuran formulated as FURADAN 480F^{TM} in order to protect the Burrowing Owl. The compromise reached between the two departments was a restriction, implemented as a supplementary label, which prohibits the use of FURADAN

480F™ within a minimum of 250 m of an occupied Burrowing Owl burrow.

The effectiveness of such a regulatory action is dependant on the information about the restriction reaching landowners and pesticide users. An information campaign was launched in 1990 through the distribution of pamphlets and radio advertising to raise awareness of the issue and the restrictions. A survey of 115 landowners registered with "Operation Burrowing Owl" in 1990 indicated that 50% were aware of the restrictions. A similar survey the following year indicated that 70% of 124 landowners were now aware of the restrictions. The true effectiveness of this regulatory action will only be properly assessed in years of severe grasshopper infestations when landowners are confronted with a significant pest control problem.

GRANULAR FORMULATIONS OF CARBOFURAN

In June 1989, AC announced the re-evaluation of all uses of flowable and granular formulations of carbofuran because of EC's concerns about its potential impact on birds. The concern originates from the extreme toxicity of carbofuran, a carbamate insecticide, to a broad range of species. The acute toxicity of this insecticide, as determined by the laboratory-derived LD_{50}, is below 1 mg/kg for two waterfowl species tested as well as some songbird species (Eisler 1985). Between 1986 and 1990, 109 reported bird kills that included over 70 different species in North America, were attributed to carbofuran poisoning. Among these were numerous eagles, hawks, vultures, and other birds of prey which received a lethal dose while feeding on contaminated waterfowl and songbird carcasses. These secondary poisonings suggest that a large amount of carbofuran-induced mortality goes undetected by the authorities but not by the local raptor and scavenger populations. Although EC's concern regards both formulations, only the case against the granular, as it relates to the Canadian prairies, will be discussed here.

Two granular formulations of carbofuran are registered for use in western Canada: FURADAN 5G™ and FURADAN CR-10™ are registered for use on canola and mustard at planting for the prophylactic control of flea beetles. Only the latter is in current use. Granular insecticides are incorporated into the soil at the time of seeding. Much of the concern with granular formulations comes from their similarity, both in size and shape, with grit consumed by birds. In the case of FURADAN, the dose of carbofuran contained in one CR-10 granule is enough to kill a small- to medium-bodied bird. In one reported bird kill at Vonda, Saskatchewan, in 1984, it is estimated that well over two thousand Lapland Longspurs (*Calcarius lapponicus*) were killed after a quarter section of canola was treated with FURADAN CR-10™ (CWS 1992).

Granular insecticides are used over extensive areas of the northern prairies. Estimates range from 0.37 to 0.54 million hectares treated yearly between 1981 and 1985. Peak seeding for canola occurs in mid-May when the largest flocks of migratory birds move across the prairies. Of particular concern are those species which migrate in large flocks and use open agricultural land for foraging such as longspurs, Horned Larks (*Eremophila alpestris*), or buntings. Such flocks commonly consist of as many as 10,000 birds which may cover an entire quarter section. It is therefore, our concern that a few incidents such as the one observed in Saskatchewan in 1984 could have serious consequences for the populations of some of these species.

Table 1. Proportion of surface-visible granules in field crops (from Maze et al. 1991).

Seeding Implement	Fallow (%)	Stubble (%)	Surface count[a] (per hectare)	Popularity of seeding implement
Press drill	5.30	4.70	66,300	high
Hoe drill	0.74	0.37	9,100	low
Air seeder[b]	0.31	0.92	3,800	low
Air seeder (broadcast)	4.20	2.20	52,500	low

[a] Based on proportions obtained on fallow

[b] Either type of application was followed by a harrow-packing operation

EC sponsored an engineering study to determine the availability of granules to birds following incorporation into the soil (Maze et al. 1991). The highest average surface residues were 5.3% of the amounts applied with a press drill or approximately 7 granules/m^2 (Table 1). Hot spots were encountered with counts as high as 33 granules/m^2. It is important to note that the kill reported in Saskatchewan in 1984 occurred following the application of the granules with an air seeder used to broadcast the seed, followed by a harrow/packer. According to Table 1, this is not the most popular seeding implement but, more importantly, it leaves fewer granules on the surface than the more popular press drill. This evidence suggests that the availability of granules to birds is high and that the potential exposure to the insecticide is of great concern.

The case against carbofuran as assembled by EC is now before AC and a regulatory decision is pending. In the United States, the Environmental Protection Agency (EPA) negotiated a settlement with the manufacturer to withdraw all but five very minor uses of granular carbofuran since "none of the risk reduction measures [evaluated by the EPA] were adequate to reduce the risk to birds, given the high toxicity of carbofuran granules." Furthermore, the State of Virginia recently conducted an extensive survey which showed that bird kills were found in every planted field despite such drastic risk reduction measures as wide buffer zones on the edges of fields, devices to shut off granule flow in turn areas or extensive training programs for the applicators. A complete ban on carbofuran granulars is now in effect in that state.

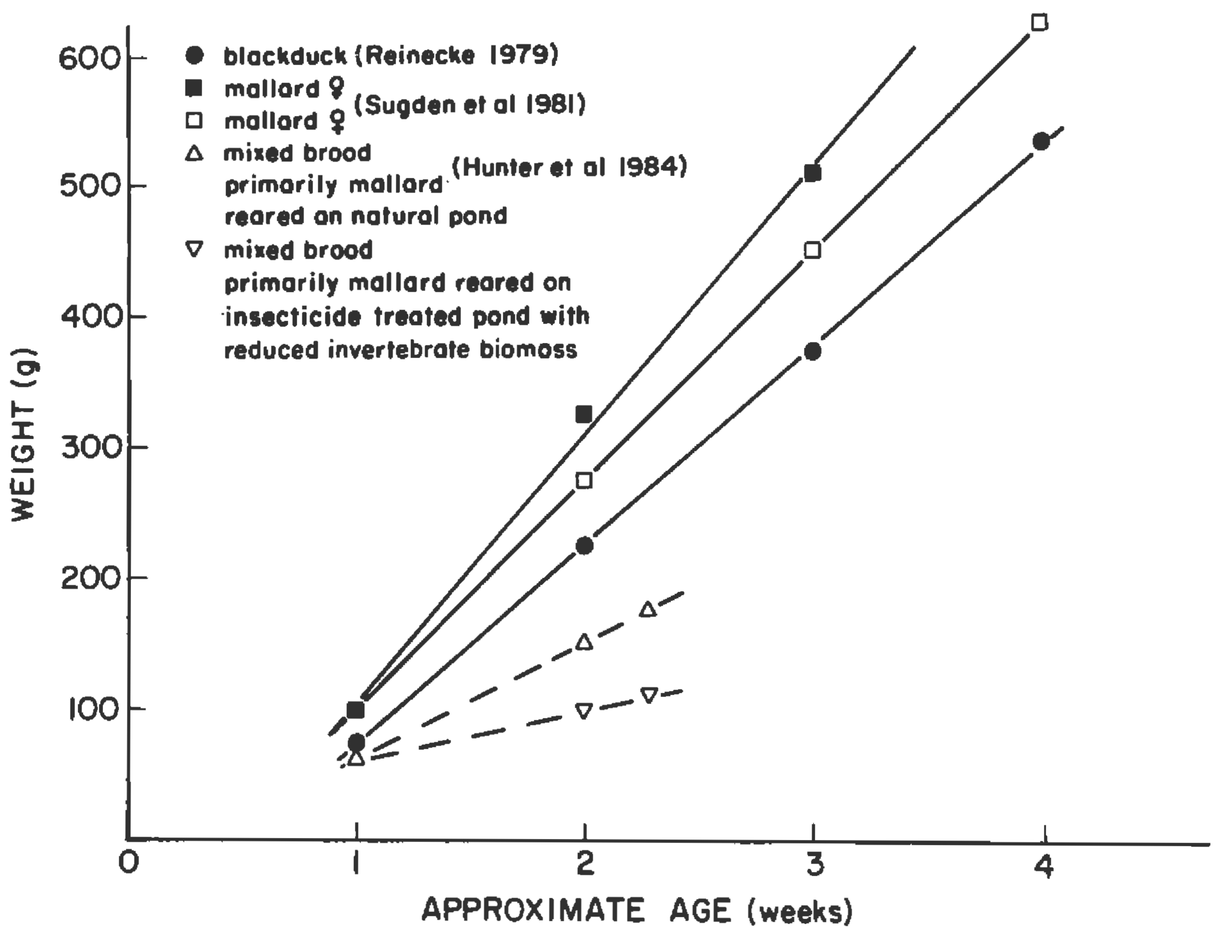

Figure 1. Growth of Black Duck (*Anas rubripes*) and Mallard (*A. platyrhynchos*) ducklings during weeks one through four of age. Optimal growth rates for laboratory reared birds (Reinecke 1979 and Sugden et al. 1981) are compared to those of experimental broods reared in natural habitats both treated and untreated with the insecticide carbaryl (from Sheehan et al. 1987).

AERIAL APPLICATION OF INSECTICIDES IN THE PRAIRIE POTHOLE REGION

Our concern regarding the aerial application of insecticides in the prairie pothole region centres around the potential reduction in the invertebrate food supply of laying hens and ducklings when wetlands are contaminated by insecticide drift or overspray. We argue that in this type of wetland environment, where average wetland densities can reach 28/km^2 or more, covering as much as 20% of the land area (National Wetlands Working Group, 1988), even under the best application conditions, contamination of a significant level is likely (Sheehan et al. 1987). The prairie pothole region overlaps large parts of the prairie agricultural region and, thus, the wetlands are surrounded by cultivated fields.

Waterfowl depend on the rich and productive aquatic invertebrate populations of prairie wetlands during critical periods in their life cycle. Female ducks require a diet rich in protein and calcium for egg laying. Ducklings of all species require a diet rich in protein in the first few weeks after hatching for rapid growth. This is essential for surviving predation and extremes in temperature typical of prairie springs. Both for the hen and the ducklings, this diet rich in protein and calcium originates for the most part from the aquatic invertebrates thriving in the wetlands.

In one study on the effect of the insecticide carbaryl on the growth of ducklings in ponds, the authors found that the growth was reduced by about 40% when compared to a control group (Hunter et al. 1984). Figure 1 illustrates the growth of the ducklings on the control and treated ponds, and for laboratory reared birds. Of 13 insecticides registered for use in the Canadian prairies, carbaryl is one of the least toxic to aquatic invertebrates (Sheehan et al. 1987). An assessment of risk to the aquatic invertebrates based on the modelling of fate and persistence, and short-term laboratory test data, showed carbaryl to be of relatively low risk to the resource (Table 2). We can therefore conclude that many of the insecticides registered for use in Canada may have a much more substantial impact on the wetlands of the prairies and, thus, on duckling growth and survival.

To further address the issue, EC is planning to conduct a study, in cooperation with commercial applicators, to follow the drift of a spray cloud following the

Table 2. Relative hazard ranking of 13 insecticides to aquatic invertebrates based on model of partitioning and persistence and short-term laboratory toxicity test data (from Sheehan et al. 1987).

Ranking Based on Toxicity Test Data	Ranking Based on Risk Model: Acidic Pond	Ranking Based on Risk Model: Alkaline Pond	
deltamethrin	permethrin	permethrin	HIGH
cypermethrin	azinphos methyl	chlorpyrifos	RISK
fenvalerate	chlorpyrifos	deltamethrin	
permethrin	deltamethrin	methoxychlor	
azinphos methyl	methoxychlor	cypermethrin	
malathion	cypermethrin	azinphos methyl	
methoxychlor	phosmet	fenvalerate	
chlorpyrifos	malathion	diazinon	
carbaryl	fenvalerate	phosmet	
diazinon	carbaryl	malathion	
phosmet	diazinon	carbaryl	
carbofuran*	carbofuran*	dimethoate	LOW
dimethoate	dimethoate	carbofuran*	RISK

* The ranking for carbofuran is tentative as little aquatic toxicity information was available

application by air of a tracer dye to fields adjacent to or containing wetlands. Measurements of deposition on the wetlands will assist in determining the likelihood and extent of contamination under a variety of operational conditions. Presently, a 100 m no-spray zone around wetlands is required when aerially applying synthetic pyrethroids, a class of insecticides extremely toxic to aquatic invertebrates. This study will evaluate the effectiveness of this regulatory requirement in protecting the resource.

LITERATURE CITED

Canadian Wildlife Service. 1992. The hazard of carbofuran to birds and other vertebrate wildlife. CWS contribution to Agriculture Canada Discussion Document on Carbofuran.

Eisler, R. 1985. Carbofuran hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildl. Serv. Biol. Rep. 85(1.3). 36 pp.

Environment Canada/Agriculture Canada. 1987. Pesticide Registrant Survey: 1987 Report. Prepared by Commercial Chemicals Branch, Conservation and Protection, Environment Canada, October, 1987.

Fox, G.A., P. Mineau, B. Collins and P.C. James. 1989. The impact of the insecticide carbofuran (Furadan 480F) on the Burrowing Owl in Canada. Technical Report Series No. 72. Canadian Wildlife Service, Ottawa.

Hunter, M.L. Jr., J.W. Witham and H. Dow. 1984. Effects of carbaryl-induced depression in invertebrate abundance on the growth and behavior of American black duck and mallard ducklings. Can. J. Zool. 62:452-456.

Maze, R.C., R.P. Atkins, P. Mineau and B.T. Collins. 1991. Measurement of pesticide residue in seeding operations. Trans. Amer. Soc. Agric. Eng. 34(3):795-799.

National Wetlands Working Group, 1988. Wetlands of Canada. Ecological Land Classification Series, No. 24. Sustainable Development Branch, Environment Canada, Ottawa, Ontario, and Polyscience Publications Inc., Montréal, Québec. 452 p.

Reinecke, K.J. 1979. Feeding ecology and development of juvenile black ducks in Maine. Auk 96:737-745.

Sheehan, P.J., A. Baril, P. Mineau, D.K. Smith, A. Harfenist and W.K. Marshall. 1987. The impact of pesticides on the ecology of prairie nesting ducks. Technical Report Series No. 19.

Sugden, L.G., E.A. Driver and M.C.S. Kingsley. 1981. Growth and energy consumption by captive mallards. Can. J. Zool. 59(8):1567-1570.

Wedgwood, J.A. 1978. Status report on Burrowing Owl *Athene cunicularia* in Canada. COSEWIC Status Report. Committee on the Status of Endangered Wildlife in Canada, Ottawa. 84 pp.

STUDIES ON THE IMPACT OF AGRICULTURAL AND FORESTRY HERBICIDES ON NON-TARGET AQUATIC PLANT COMMUNITIES

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Herbicides (synthetic organic chemicals that specifically kill plants) are an important component of modern agricultural and forestry practices. Herbicides increase crop yield by reducing losses to competing vegetation while reducing labor costs associated with control, thereby making them more cost-effective than other methods of crop protection. A compilation of data from the Manitoba Department of Agriculture (Figure 1) demonstrates that the agricultural use of phenoxy herbicides (principally 2,4-D and MCPA) in the three prairie provinces increased markedly in the 1950s and 1960s, then stabilized in the 1970s and 1980s, by which time approximately half of the arable land in this area was treated. Other "specialty" herbicides, including those for control of Wild Oats (*Avena fatua*), saw increasing use through the 1970s. The net result has been that the quantity and diversity of herbicides used in agriculture has increased significantly in the last two decades. At the same time, uses of herbicides in forestry for site preparation and seedling

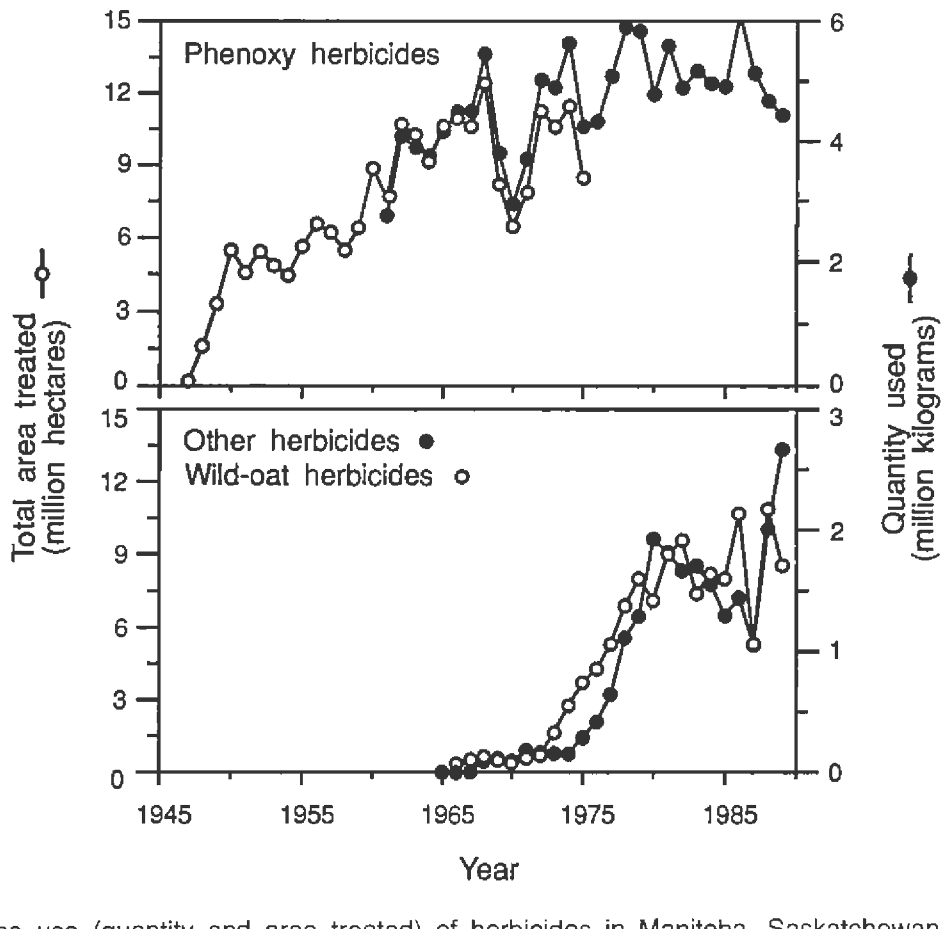

Figure 1. The use (quantity and area treated) of herbicides in Manitoba, Saskatchewan, and Alberta between 1947 and 1989. Categories are those used by the Manitoba Department of Agriculture. Statistics for phenoxy herbicides include 2,4-D and MCPA, "other" herbicides include bromoxynil, dicamba, dichloroprop, linuron, roundup, stampede, tordon, and unspecified others, and wildoat herbicides include asulox, atrazine, avadex, avenge, carbyne, eptam, eradicane, hoegrass, mataven, and treflan. Data were obtained from Anonymous (1947 to 1989).

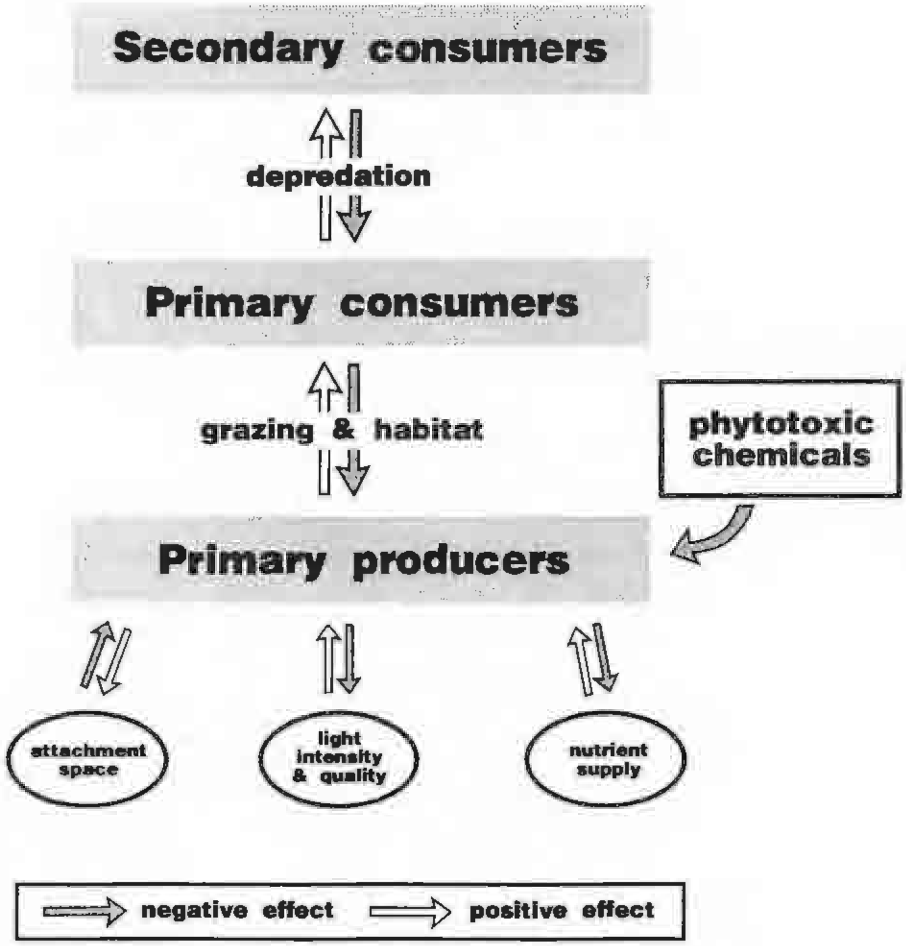

Figure 2. Schematic diagram of some of the natural factors (light, space, and nutrients) and anthropogenic factors (phytotoxic chemicals) influencing primary producers (algae and macrophytes) in aquatic environments. According to the concept of bottom-up control, changes in primary producer biomass or species composition result in altered energy availability to subsequent trophic levels (herbivores and their predators), causing "ripple" effects through the entire ecosystem.

release have increased, although the quantity used is estimated to be less than 1% of that in agriculture.

Given the widespread terrestrial use of herbicides in Canada, the potential is high for off-site movement of herbicide residues in spray drift, adsorbed to wind-borne soil particles, or via runoff water into the aquatic environment. For example, Frank et al. (1990) reported that 84 of 122 rural ponds in Ontario contained detectable residues of at least one herbicide; three ponds contained residues of at least five herbicides. Although Canada is often perceived as having abundant water resources, much of this water is geographically remote or non-potable (e.g., saline). Contamination from herbicide introduction to water reduces the supply of potentially usable water, particularly since the areas of greatest agricultural herbicide use may coincide with areas of fewest surface water supplies (e.g., the southern prairies). One result of this surface water contamination is that algae and macrophytic plants are directly impacted (Figure 2). Due to the bottom-up control of aquatic food webs (McQueen et al. 1989), impacts on these primary producers can affect the availability and quality of food and habitat of aquatic invertebrates, vertebrates, and waterfowl. In other words, direct negative effects on aquatic plants will result in indirect negative effects throughout the aquatic ecosystem. Therefore, it is important to examine the impact of herbicides in the aquatic environment on non-target plant communities. This has been the subject of my research for the past ten years, some results of which I will describe briefly below.

SHORT-TERM EC50 DETERMINATIONS

To investigate the short-term effect of herbicides on algae, I determined the static EC50 (effective herbicide concentration causing a 50% reduction in photosynthetic rate) to natural periphyton (attached algae) communities. Acrylic rods were positioned in the Delta Marsh, Manitoba (50°11'N 98°23'W) and in boreal ponds north of Pine Falls, Manitoba (50°44'N 96°9'W) as surfaces for periphyton colonization. After two to four weeks, colonized substratum segments (2.5 cm long) were collected and placed into filtered water from the site of collection (containing no herbicide residues). They were transported to the laboratory, where a known concentration of an aqueous herbicide solution was added, along with a standard quantity of radiolabelled sodium bicarbonate as a carbon tracer for the determination of carbon dioxide uptake rates. Three replicate determinations were made for each herbicide concentration. The periphyton samples were incubated at a constant temperature under a standard light source for three to four hours. Then the algae were retrieved via filtration and placed into scintillation vials for determination of radioactivity. The resulting data, along with measurements of total available carbon in the water samples, were used to calculate algal photosynthetic rate per unit of substratum surface area (%gC/cm/h). Rates for samples treated with herbicide are expressed relative to those of untreated control samples. EC50 values (mg/L) were calculated by standard probit analysis (Statistical Analysis System 1986). Lower EC50 values indicate greater phytotoxicity.

The photosynthetic response of natural periphyton samples to herbicides is a convenient bioassay for the more general impact of herbicides on non-target plants since periphyton is readily sampled, easily manipulated in the laboratory, and may provide data on the response of a natural plant assemblage that is more ecologically meaningful than those from unispecific laboratory bioassays typically used in toxicity evaluations. A typical dose-response function (Figure 3) shows the relationship of periphyton photosynthesis to the concentration of hexazinone (the active ingredient in the Velpar® commercial formulation used in forestry) in the incubation medium. At low hexazinone

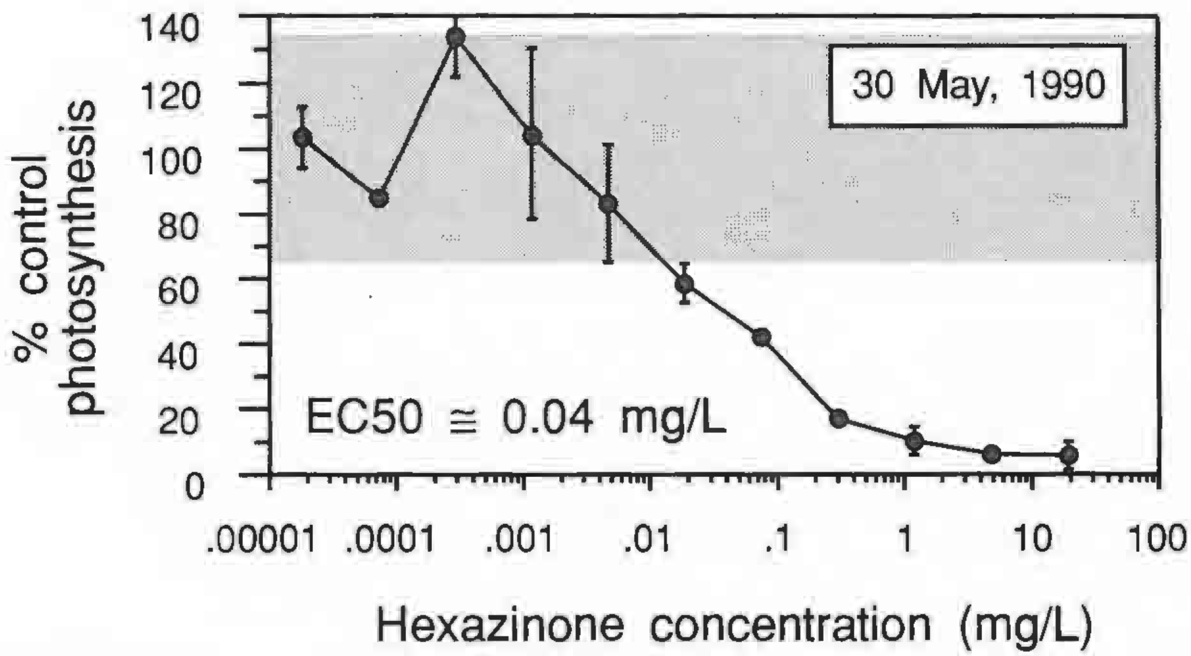

Figure 3. A typical dose-response relationship between herbicide concentration and periphytic algal rate of photosynthesis (% of untreated controls). These data show the response of periphyton collected from the Delta Marsh on May 30, 1990 to hexazinone, a triazine herbicide that is a potent inhibitor of photosystem II of photosynthesis. Each data point is the mean of three replicate determinations and the vertical bars are the standard deviations of those replicates. The horizontal shaded area is the standard deviation of untreated control samples; values within this area are not significantly different from the control. The calculated EC50 is 0.04 mg/L hexazinone.

concentrations, no inhibitory effect on photosynthesis was observed, although in some cases, photosynthetic activity was apparently stimulated over that observed in controls. The reasons for this stimulus may relate to secondary effects of the herbicide on plant metabolism. Within some range, increasing herbicide concentration decreased photosynthesis, until some asymptotic value was reached, above which no further decline was seen. For some herbicides, measurable photosynthesis (taking dark uptake of radiotracer into account) occurred even at the highest herbicide concentration tested, suggesting that some degree of physiological resistance to herbicides exists in natural periphyton communities. Since the periphyton samples are generally composed of several algal taxa, however, the species exhibiting herbicide tolerance cannot be identified and likely varies with the herbicide being tested. Replicate determinations usually exhibited more variability than is expected in unispecific laboratory bioassays, due to variation in algal biomass resulting from spatial differences in algal colonization, accrual, faunal grazing, and algal detachment. In cases of high replicate variability, estimation of EC50 was difficult.

Repeated measurements of EC50 for a given herbicide for periphyton samples from different sample sites and different times of year produced a range of values, likely due to the differences in the respective tolerances to berbicide of the component species making up the assemblage at the time of sampling, and the temporal succession that can occur in the course of a few weeks in natural periphyton communities. Of the herbicides for which sufficient EC50 determinations have been made to allow a comparison, there was considerable variation in the degree of phytotoxicity (Table 1). Hexazinone was the most toxic of the herbicides tested, with EC50 values generally around 0.2 mg/L. Simazine, a related triazine herbicide that is used agriculturally and may be used for control of filamentous algae and macrophytes in farm dugouts (Princep® or Simadex®), was less toxic with EC50s between 0.51 and 0.86 mg/L. Sethoxydim (the active ingredient in Poast®, which is used widely for weed control in broadleaf crops) was less toxic (Table 1). The least toxic herbicides of those tested were difenzoquat (found in Avenge® used for Wild Oat control in cereal crops) and glyphosate (the active ingredient in Roundup® used agriculturally for broad spectrum weed control, Vision® used silviculturally for "conifer release," and in several home-and-garden products), with EC50 values in the range of 35 to 70 mg/L.

A concern on the use of these data is that effects of the herbicides may not be manifested during a three or four hour exposure during the bioassay particularly if the herbicide primarily targets some aspect of plant metabolism other than photosynthesis. Thus the EC50s may underestimate the potential impact on plants exposed to environmentally realistic concentrations. Despite this, however, it is clear that some of the herbicides tested could lead to short-term negative effects on natural non-target periphyton communities in streams and ponds receiving herbicide residues from terrestrial sources. For example, studies on hexazinone residues in streamflow draining treated terrestrial sites have shown that although levels are usually low (e.g., Lavy et al. 1989 report values in the range of 0.001 to 0.003 mg/L, with the maximum after a storm of 0.016 mg/L), transient peaks as high as 0.442 mg/L (Neary et al. 1983) and 0.085 mg/L (Williamson 1988) have been reported, in the latter case from a site in eastern Manitoba. Given some EC50 values for hexazinone as low as 0.04 mg/L (Table 1), short-term impact on periphyton communities in receiving waters could be anticipated.

Table 1. Concentration (mg/L) of selected agricultural and forestry herbicides causing a 50% reduction in short-term (three to four hours) photosynthetic rate of periphytic algal communities (EC50). Ranges of several EC50 determinations for each herbicide are shown.

Herbicide	Active ingredient	EC50 (mg/L)
Velpar	hexazinone	0.04-0.38
Pricep/Simadex	simazine	0.51-0.86
Poast	sethozydim	2.5-8.6
Avenge	difenzoquat	38-67
Roundup	glyphosate	35-70

ENCLOSURE EXPERIMENTS

To investigate the effects of herbicides on periphytic algal communities over a longer time period than used in EC50 experiments, I used a series of in situ enclosures positioned in the Delta Marsh, Manitoba (50°11'N 98°23'W). Initial experiments used cylindrical PVC enclosures 78 cm in diameter and 90 cm high, enclosing a volume of about 300L (Goldsborough and Robinson 1986, 1988). A known concentration of herbicide was added to some enclosures while leaving others as untreated controls. Periphyton biomass (expressed as the quantity of the primary photosynthetic pigment, chlorophyll a) and productivity (rate of photosynthesis measured as above) on acrylic rods positioned in each enclosure were monitored at weekly intervals over a period of six to ten weeks. Water samples were also collected to assess changes in water quality (dissolved oxygen and nutrients) and the quantity of herbicide residues. The effects of herbicide treatment were determined by comparing enclosed water chemistry and periphyton growth in controls with that in treated enclosures.

A shortcoming of this design is that light reduction and restriction of water flow by enclosure walls results in a unique set of chemical and physical conditions within the enclosure ("enclosure effects"), causing different degrees of algal colonization of acrylic rods in a fixed time, with different community composition. Thus, the utility of such small enclosures in toxicological investigations appears to be limited to comparisons of growth in treated enclosures to that in untreated controls. Extrapolation to natural periphyton (and other non-target plant communities) is limited to general trends rather than to specific results. An additional problem is that the study site in the Delta Marsh is prone to rapid fluctuations in water depth due to wind-induced setup of Lake Manitoba to which the marsh is connected. These fluctuations can result in enclosure flooding and loss of herbicide.

To overcome these problems, later experiments used larger enclosures (150 cm diameter by 90 cm high; volume about 1200L) that telescoped with increasing water level to prevent water exchange with the surrounding marsh (Goldsborough et al. 1986). Most recently, I have used 5 m by 5 m square enclosures containing about 21,000L to avoid enclosure effects. The advantage of these over earlier designs is that they are sufficiently large to account for the spatial heterogeneity in macrophyte distribution in the marsh, so a more realistic assessment of the impact of herbicide treatment on a natural marsh channel including macrophytes is obtained. In earlier enclosure experiments, macrophytes were harvested prior to the study to avoid confounding effects of varying quantities and species of macrophytes enclosed within any given small enclosure.

In studies in 1991 using these large littoral enclosures, I observed that the magnitude of enclosure effects appears to have been reduced from earlier designs. However, the necessity of restricting water flow through enclosure did result in lower turbidity within enclosures than in the surrounding marsh, where wind action causes considerable sediment resuspension (e.g., Kotak and Robinson 1991). Four enclosures were established, permitting two to be treated with 0.2 mg/L hexazinone (a concentration in the middle of the EC50 range defined earlier) with two as untreated controls. Acrylic rods were positioned within all enclosures and outside the enclosures to evaluate the magnitude of enclosure effects within enclosure controls. Water samples from all enclosures were collected twice weekly and analyzed chemically for dissolved nutrients and oxygen, and the concentration of the parent herbicide. I found that since hexazinone is relatively water soluble (33,000 mg/L), it dissipated from the water column of the treated enclosures very slowly. No herbicide was detected in the water of the control enclosures. The herbicide concentration at the end of the experiment (seven weeks after herbicide addition) was not significantly different from the initial concentration.

Interestingly, I observed a bloom of phytoplankton (consisting of an organism yet unidentified) occurring in both treated enclosures seven to 10 days after treatment, suggesting that it was physiologically tolerant of this concentration of hexazinone. The depletion of ammonia from enclosure water (which had increased significantly with treatment due possibly to release from decomposing macrophytes and enhanced sediment efflux) coincided with the bloom, suggesting that the algae was photosynthesizing actively. Periphyton biomass and productivity were reduced from pre-treatment levels (to about 20% of levels in control enclosures) although both parameters increased relative to the controls with time (Figure 4), indicating perhaps that community composition was shifting in favor of herbicide-tolerant biotypes. Submerged macrophytes, primarily Sago Pondweed (*Potamogeton pectinatis*) and Water Milfoil (*Myriophyllum exalbescens*), were abundant in the control enclosures, as in the surrounding marsh, but they were eliminated from treated

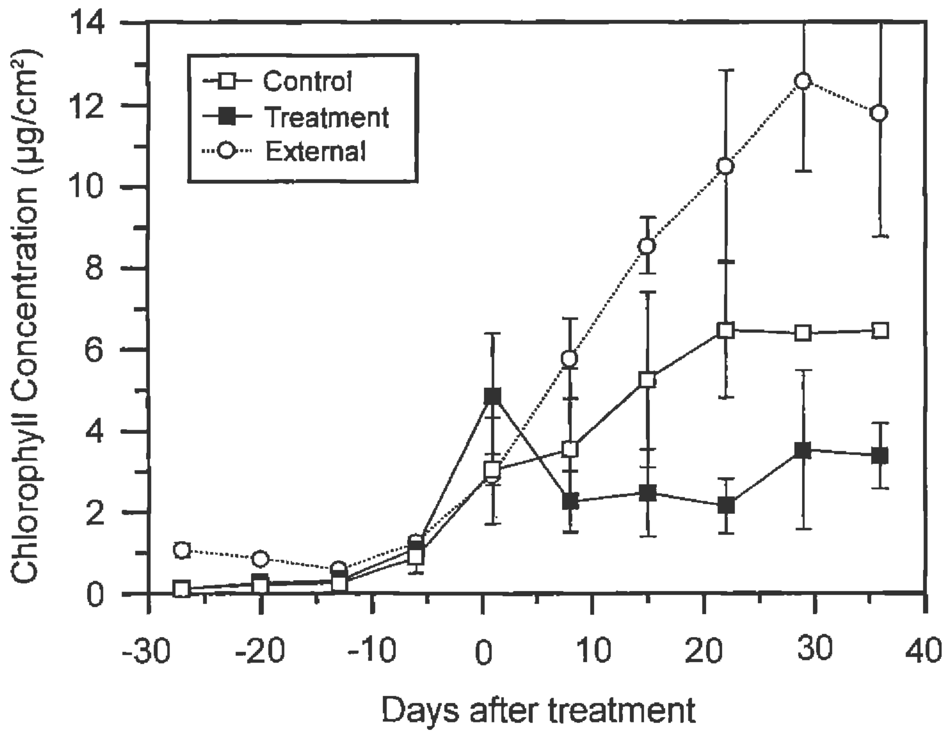

Figure 4. Change in periphyton biomass (µg/cm^2 chlorophyll) over time in enclosures treated with 0.2 mg/L hexazinone at day 0 (solid squares), in untreated enclosures (open squares), and in the surrounding marsh (open circles). Error bars are the standard deviations for two replicate enclosures per treatment.

enclosures within a few days of treatment and did not reappear during the subsequent seven weeks.

WHOLE-POND MANIPULATIONS

The most realistic assessment of the impact of herbicides on non-target plants in receiving waters would involve monitoring the effects of treatment of entire aquatic systems. In 1985, I initiated a study under the Canada/Manitoba Partnership in Forestry Agreement to investigate the potential effects of silvicultural use of the herbicide glyphosate on plants in water bodies that might be oversprayed accidentally during treatment of tree plantations in the southeastern boreal forest of Manitoba. For this study, eight small ponds (0.2 to 0.7 ha surface area, mean depth 0.9 to 1.5 m) in an area subject to glyphosate use (but which had not received herbicide) were selected and fully characterized with respect to water quality (ion and nutrient chemistry), sediment texture and chemistry, periphytic and phytoplanktonic algal biomass (chlorophyll concentration) and productivity (rate of photosynthesis), and macrophyte richness (presence/absence) and abundance (standing crop). Following a 1.5 year period of study, the ponds were assigned to pairs having similar chemical and biological properties.

In late 1986, one member of three of the pairs were intentionally oversprayed with an operational concentration of glyphosate (2.5 kg/ha). Monitoring of water quality (including glyphosate and metabolite residues) and plant production continued, with the objective of determining if any measured parameter deviated out of the normal range of variation observed in the preceding characterization period, as compared to the other member of the pond pair. In 1987, two of the treated ponds from the preceding year (and one additional pond untreated in 1986) were retreated with 6.0 kg/ha glyphosate (the high end of the recommended dosage for forestry). Consequently, of eight ponds, two were treated twice (representing a worst-case contamination scenario), one was treated once in 1986, one was treated once in 1987, and four were untreated controls. Monitoring was discontinued in 1989, but has recommenced in the spring of 1991 to evaluate longer-term effects of herbicide application on the plant communities of treated ponds.

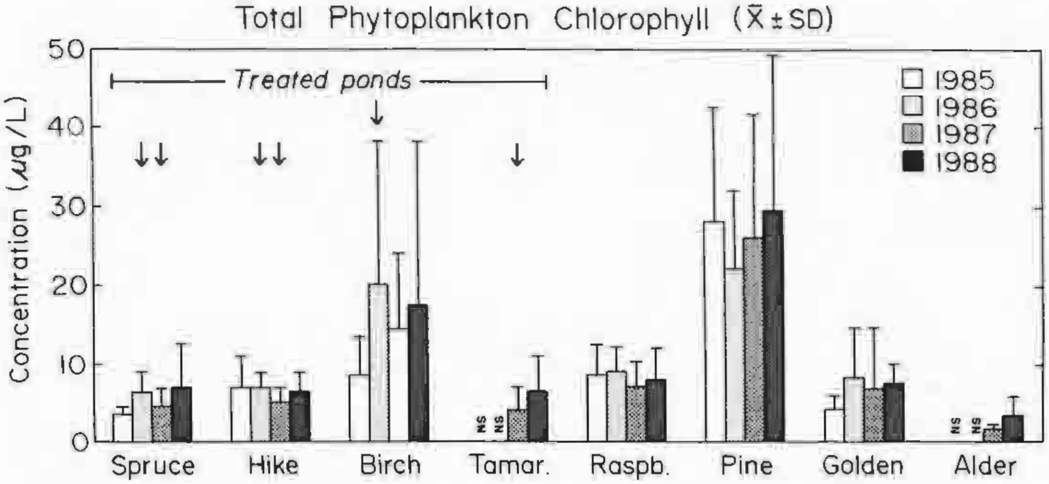

Figure 5. Seasonal mean phytoplankton biomass (µg/cm^2 chlorophyll) in eight study ponds in the southeastern boreal forest of Manitoba (1985 to 1988). The four ponds to the left were treated with operational concentrations of glyphosate (2.5 kg/ha in 1986, 6.0 kg/ha in 1987), while the four ponds to the right were untreated. Vertical arrows indicate the years of treatment. Error bars are the standard deviation of determinations made throughout the ice-free period in each pond. NS = no samples.

Until data analyses are completed in 1993, it will not be possible to evaluate the long-term impact of herbicide contamination on primary production of treated ponds. Glyphosate dissipated rapidly from the water of treated ponds, with first-order dissipation half-lives of less than 14 days (Goldsborough and Beck 1989; Goldsborough and Brown, in press); the maximum glyphosate concentration observed immediately after application was 0.12 mg/L. Comparing this to the static EC50 values for glyphosate (Table 1), it would appear that effects on algal productivity are unlikely, despite the earlier caveat on the extrapolation of EC50 values to prediction of longer-term effects. Water chemistry varied widely between ponds and within a given pond over time; however, from preliminary analyses, it does not appear that water chemistry was altered due to herbicide treatment. Comparisons of annual mean phytoplankton biomass (Figure 5) and periphyton biomass (Figure 6) demonstrate the high variability between ponds; differences between years in any given pond were minor. We did observe that periphyton biomass increased slightly in treated ponds in

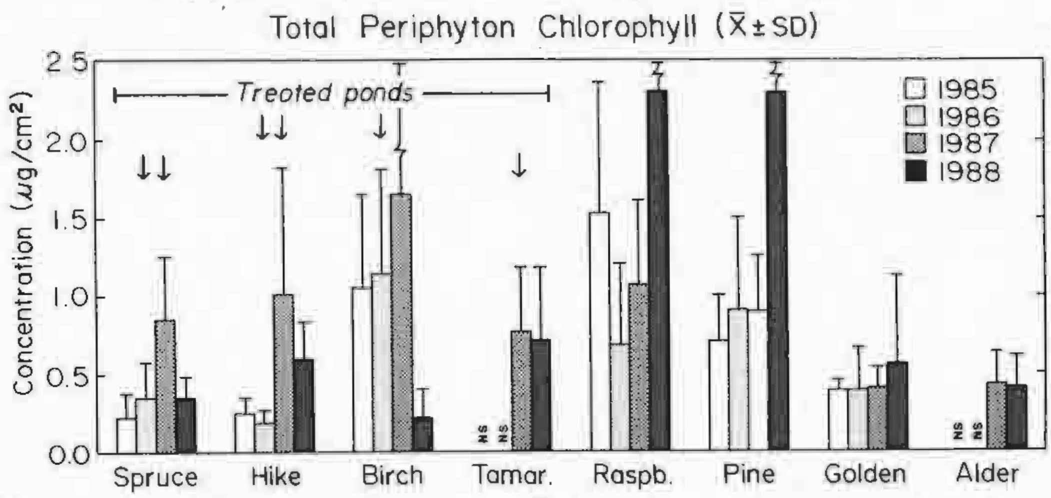

Figure 6. Seasonal mean periphyton biomass (µg/cm^2 chlorophyll) in eight study ponds in the southeastern boreal forest of Manitoba (1985 to 1988). The four ponds to the left were treated with operational concentrations of glyphosate (2.5 kg/ha in 1986, 6.0 kg/ha in 1987), while the four ponds to the right were untreated. Vertical arrows indicate the years of treatment. Error bars are the standard deviation of determinations made throughout the ice-free period in each pond. NS = no samples.

the spring following the first herbicide application, which might be a response to increased nutrient availability (as proposed by Holtby and Baillie 1989) due possibly to delayed development of littoral emergent macrophyte populations in those ponds. By mid-season, no qualitative difference in macrophyte distribution or composition in treated ponds could be observed, and no difference in flowering phenology was seen.

CONCLUSION

It is clear that herbicides may enter natural fresh waters in western Canada. There is evidence, from short-term bioassays and from in situ manipulative experiments, that these herbicides may affect either the biomass or composition of non-target plants at residue concentrations that may occur in receiving waters. Unfortunately, the importance of aquatic primary producers to the functioning of aquatic food webs is often not fully appreciated, so that considerations of "endangered species" may not consider indirect factors such as habitat or food availability and quality, which may be equally important to direct toxicity in determining the survival of an endangered population. Research attention should focus on those organisms that are primarily targeted by environmental contaminants (such as plants in the case of herbicides) in programs concerned with preservation of ecosystems and their constituent organisms.

ACKNOWLEDGMENTS

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LITERATURE CITED

Anonymous 1947-1989. Herbicides used for agricultural weed control in western Canada. Manitoba Department of Agriculture, Economics Branch, Statistics Section.

Frank, R., H.E. Braun, B.C. Ripley, and B.S. Clegg. 1990. Contamination of rural ponds with pesticide, 1971-85, Ontario, Canada. Bulletin of Environmental Contamination and Toxicology 44:401-409.

Goldsborough, L.G. and A.E. Beck. 1989. Rapid dissipation of glyphosate in small forest ponds. Archives of Environmental Contamination and Toxicology 18:537-544.

Goldsborough, L.G. and D.J. Brown. Dissipation of glyphosate and aminomethylphosphonic acid in water and sediments of boreal forest ponds. Environmental Toxicology and Chemistry. In press.

Goldsborough, L.G. and G.G.C. Robinson. 1986. Changes in periphytic algal community structure as a consequence of short herbicide exposures. Hydrobiologia 139:177-192.

Goldsborough, L.G. and G.G.C. Robinson. 1988. Functional responses of freshwater periphyton to short simazine exposures. Verh. Internat. Verein. Limnol. 23:1586-1593.

Goldsborough, L.G., G.G.C. Robinson and S.E. Gurney. 1986. An enclosure/substratum system for in situ ecological studies of periphyton. Archiv für Hydrobiologie 106:373-393.

Holtby, L.B. and S.J. Baillie. 1989. Effects of the herbicide Roundup (glyphosate) on periphyton in Carnation Creek, British Columbia. BC Ministry of Forests Forest Resource Development Agreement Report FRDA 063:224-231.

Kotak, B.G. and G.G.C. Robinson. 1991. Artificially-induced water turbulence and the physical and biological features within small enclosures. Archiv für Hydrobiologie 122:335-349.

Lavy, T.L., J.D. Mattice and J.N. Kochenderfer. 1989. Hexazinone persistence and mobility of a steep forested watershed. Journal of Environmental Quality 18:507-514.

McQueen, D.J., M.R.S. Johannes, J.R. Post, T.J. Stewart and D.R.S. Lean. 1989. Bottom-up and top-down impacts on freshwater pelagic community structure. Ecological Monographs 59:289-309.

Neary, D.G., P.B. Bush and J.E. Douglass. 1983. Off-site movement of hexazinone in stormflow and baseflow from forest watersheds. Weed Science 31:543-551.

Statistical Analysis System. 1986. Statistics for Personal Computers, Version 6.03. SAS Institute, Cary, North Carolina.

Williamson, D.A. 1988. Hexazinone residues in surface and groundwater at two sites within Agassiz Provincial Forest, Manitoba, Canada. Water Pollution Research Journal of Canada 23:434-449.

THE PRAIRIE PESTICIDE MONITORING PROGRAM

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The Prairie Pesticide Monitoring Program monitors reproductive success and mortality in birds throughout the agricultural portions of the prairie provinces with the objective of identifying hazards posed by agricultural chemicals to songbirds. The program depends on volunteer monitors who collect data from nestboxes along fencelines adjacent to cropland. These "nestbox trails," some of which have been in place for up to 30 years (Houston 1977), are situated in both parkland and prairie ecoregions. Four species occupy the nestboxes: Mountain Bluebird (*Sialia currucoides*), Tree Swallow (*Tachycineta bicolor*), House Wren (*Troglodytes aedon*), and Eastern Bluebird (*Sialia sialis*), with the latter occurring primarily in Manitoba, where the ranges of the two bluebird species overlap. Nestboxes have the advantages of a relatively low rate of predation, protection from many types of external disturbance, and can be erected where desired, provided there is a fence or means of erecting a post. Although nestboxes are limiting with regard to species, those species that do occupy them represent several different feeding behaviours and hence a variety of potential dietary exposures to granular insecticides, treated seed, sprayed fungicides, insecticides, and herbicides. The timing for treatment of the more common crop pests overlaps the nesting stages of these species to a considerable extent (Figure 1). Monitoring the effects of pesticides on songbirds in agricultural cropland is a high priority of the Canadian Wildlife Service (CWS) and of the Avian Effects Dialogue Group in the United States (Anonymous 1991).

Many "bluebirders" feel that pesticides are causing deaths in nestbox species. During the grasshopper

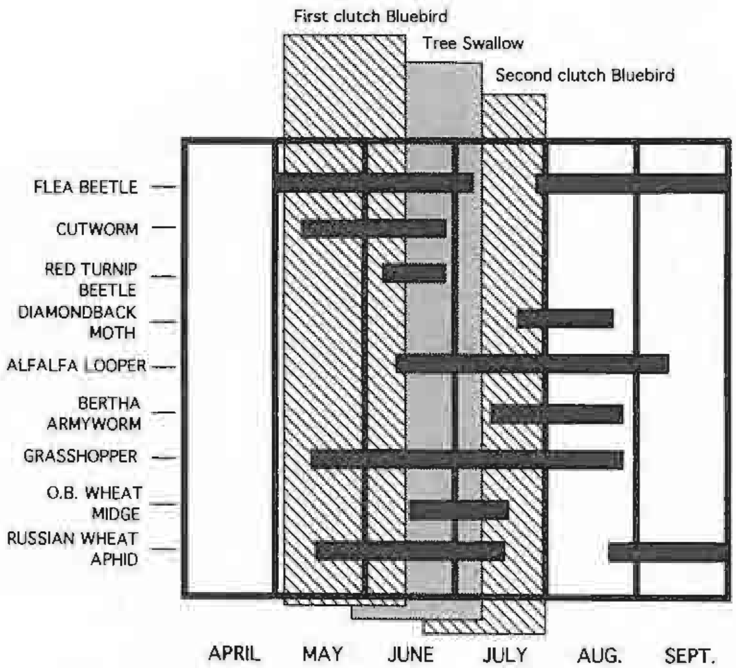

Figure 1. Timing of insecticide use in the prairie provinces in relation to nesting of Mountain Bluebirds and Tree Swallows. All bars indicate spraying with the exception of in-furrow granular or seed treatment for flea beetle (subfamily *Alticinae*) in May and June. (Data adapted from Sheehan et al. 1987, Alberta Agriculture 1985, and additional information from Saskatchewan Agriculture, pers. comm.)

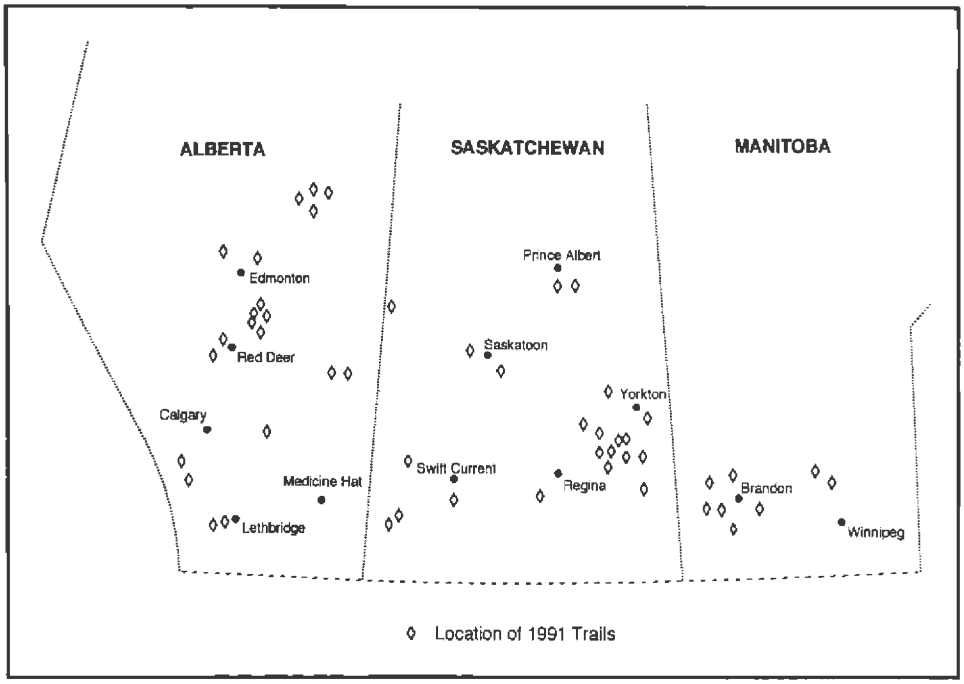

Figure 2. Participating nestbox trails in 1991.

outbreak in the mid 1980s, the authors received several reports from southern Alberta of unusual numbers of nestling mortalities in nestboxes. Observations in the informal literature deal primarily with the effects of carbaryl (Sevin®) use. In the most scientific of these reports, Sevin sprayed for Gypsy Moth (*Porthètria díspar*) at 0.45 lbs/ac (measured deposit) was followed by the death of five Tree Swallow nestlings in a nestbox 16 days after exposure (Bednarek and Davidson 1967). Examination of the data shows that the nestlings that died had hatched prior to exposure, whereas all other nests (n = 11) were exposed in the egg stage. The data also show that predation of two broods took place at the same time as these deaths and was the only predation that occurred. In addition, Wilde (1979) reported abandonment of nests, some of which contained eggs or young, by Tree and Cliff Swallows (*Petrochelidon pyrrhonata*) following dimethoate (Cygon®) application to the base of trees. Also, Eastern Bluebird nestling deaths have been reported following Sevin® application to gardens in which the adults had been foraging (Wilson 1989, Krueger 1988).

Participating trail operators record data from their nestboxes on a weekly basis. Parameters recorded include: number of eggs, nestlings, stage of nestling development (based on appearance), evidence of predation, presence of adults, and mortalities. The number of boxes to be monitored is left up to each volunteer and ranges from 5 to 60. Participants include farmers, business and professional persons, students, and retired persons. Some have placed additional nestboxes next to crops on behalf of the program and many have increased the frequency of their nestbox visits. New participating trails are evaluated by the program coordinators (Pecan Resources Inc.) with regard to habitat characteristics such as land use, type of crops, proximity of wooded areas and waterbodies, class of road, and presence of powerlines.

The program coordinators also obtain information on the pesticides applied near each nestbox from landowners, municipal authorities, and utility companies. This information and the nest records received are used to determine the stage during which exposure to pesticides occurred at each nest (pre-incubation, incubation, or nestling stage). The data are then examined for possible effects of these and other factors on clutch size, nest abandonment, nestling and adult mortality, and overall hatching and fledging success.

In 1990, the first full-scale year of operation, 39 trail operators participated. The first year's data were from relatively pesticide-free areas and were thus used to examine the influence of environmental factors on reproductive success, for example: 1) are nests beside pasture more successful than those beside crops?; 2) what weather conditions affect nestling survival in each species?; 3) are nests in parkland more productive than those in prairie habitat?; and 4) are Tree Swallow nests by water more productive than those away from water?

In 1991, the program expanded into Manitoba. Fifty trails participated (Figure 2) and sent in a total of 720 nest records. Grasshopper outbreaks occurred near some of the Saskatchewan and Manitoba trails, and monitors reported unusually poor productivity in second clutches of Mountain Bluebirds in these areas. In examining the data, we found that nest abandonment by bluebirds was associated with the use of certain insecticides. It is possible that a prolonged rainy period exerted an influence, perhaps in concert with a scarcity of insects following insecticide application.

Several years' data are required in order to discern trends, as many factors are involved. It is hoped that more trails will participate as the program continues. Anyone interested in participating is encouraged to contact the authors.

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LITERATURE CITED

Alberta Agriculture. 1985. Canola production in Alberta. Edmonton, Alberta. Agdex 149/20-1.

Anonymous. 1991. Assessing pesticide impacts on birds: discussion of the Avian Effects Dialogue Group (1989-1991). Resolve, World Wildlife Fund, Washington, D.C. 40 pp.

Bednarek, R. and C.S. Davidson. 1967. Influence of spraying with carbaryl on nesting success in a sample of bird-boxes on Cape Cod in 1965. Bird-Banding 38:66-72.

Houston, C.S. 1977. The prairie bluebird trail. Nature Canada 6:3-9.

Krueger, H. 1988. A carbaryl pesticide suspected in death of nestling Eastern Bluebirds. Sialia 10(3):93.

Sheehan, P.J., A. Baril, P. Mineau, D.K. Smith, A. Harfenist and W.K. Marshall. 1987. The impact of pesticides on the ecology of prairie nesting ducks. Tech. Rep. Series No. 19, Canadian Wildlife Service, Ottawa.

Wilde, G.A. 1979. Possible swallow response to insecticide use. Blue Jay 37:226.

Wilson, J. 1989. Sialia Feedback: Sevin, Snakes, Site Preference. Sialia 11(1):22-23.

ASSESSMENT OF THE GEOGRAPHIC RISK ASSOCIATED WITH INSECTICIDE USE AND BREEDING WATERFOWL IN THE PRAIRIE-PARKLAND ECOREGION OF ALBERTA

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INTRODUCTION

The quantity and quality of breeding waterfowl habitat on the Canadian prairie has declined significantly since the 1970s, largely due to agricultural expansion and intensification. Coupled with this has been an increasing use of pesticides, notably organophosphates, carbamates, and more recently synthetic pyrethroids. These pesticides have the potential to directly affect waterfowl and the quality of remaining habitat. Waterfowl are susceptible to pesticide use through toxicological impacts and ecological effects mediated through their nesting behaviour and food supply (Mineau et al. 1987).

Grasshopper programs have significant potential for direct impact because of the considerable geographic overlap between areas sprayed to control grasshoppers and waterfowl nesting and brood rearing habitat. In the prairie and parkland ecoregions of Alberta, four insecticides accounted for the bulk of grasshopper spraying during the period 1985 to 1989: Furadan, Decis, Lorsban, and Sevin XLR. In 1985 and 1986, two peak grasshopper infestation years in Alberta, approximately 750,000 ha were sprayed with insecticide as control. More than 50% of the area was treated with Furadan and greater than 20% treated with Decis (D. Johnson and M. Dolinski, pers. comm.).

Work by the Wildlife Toxicology and Surveys Branch of Canadian Wildlife Service (CWS) has examined the probable impacts of pesticides on waterfowl by estimating the spatial overlap between nesting ducks and a number of primary prairie crops (Grue et al. 1986). This work recommended the further development and integration of existing databases to improve estimates of the role of pesticides in contributing to waterfowl loss due to agriculture.

This paper describes the use of Geographic Information Systems (GIS) procedures and associated computer models for comparing the distribution and abundance of breeding waterfowl, waterfowl habitat conditions, and insecticide spraying as a means of assessing habitat risk to waterfowl from insecticide spraying.

Project work was divided into two phases. Phase 1 involved database acquisition, development, and GIS mapping of waterfowl and insecticide utilization, and Phase 2 involved identification of the geographic overlap among the mapped distributions to identify related factors.

STUDY AREA

The study area includes the grassland and aspen parkland ecoregions of Alberta, an area of approximately 16 million ha bounded by the 49th parallel in the south, 54 degrees latitude in the north, the Alberta-Saskatchewan border in the east, and 114 degrees in the west. This region is made up of aspen parkland, dry mixed grass prairie, mixed grass prairie, fescue grass prairie (7.3%), and elements of low boreal mixedwood and montane ecoregions (Strong 1991).

METHODS

Waterfowl and Habitat Database Development

Waterfowl survey and pond count data, collected annually by the United States Fish and Wildlife Service and CWS, were obtained from CWS in Saskatoon and Winnipeg. Segment level data were provided for Strata 26-29, for the years 1975 and 1982, two wet years, and 1985 to 1989 a period of drought.

Annual waterfowl and brood survey data are collected using a double sampling plan with stratification. The continent is broken into sample blocks or strata, each block is stratified by transect and transects broken into segment units. Segment units represent a sample strip of rectangular shape (29.97 km x 0.40 km) 11.6 km^2 in size.

Dabbling and diving ducks data were provided as total ducks, not pairs, for all species and for each survey segment. These estimates had been corrected for visibility bias using ground survey data. Brood data represented the number of broods counted for each survey segment, for all species and age classes combined. May and July ponds were provided as total ponds per survey segment.

These data were reviewed and organized and INTERA-TYDAC's SPANS (Spatial Analysis System) GIS used to produce contour maps of densities of dabbling ducks, diving ducks, broods, and May and July ponds. SPANS contouring procedure was used to interpolate segment level waterfowl and pond count point data. Modelling equations were written in SPANS to determine the density of dabbling and diving ducks by county, year, and ecoregion, and May and July pond densities by ecoregion and year. Simple pair-wise correlations (Pearson's r) among the waterfowl and habitat variables were calculated to compare populations patterns and seasonal changes.

Insecticide Purchase Database

Insecticide sales data were supplied by Agriculture Canada, Lethbridge Research Station. This database consists of the complete record of sales of 12 insecticides supported by Alberta Agriculture's Grasshopper Insecticide Rebate Program. The database was coded and checked at the Lethbridge Research Station and contains over 10,000 product sales stored by land location, quantity purchased, cost, product, and quantity sprayed.

Insecticide sales data were converted to GIS format and mapped by summing hectares sprayed for a 10 km survey grid. The sum of the hectares sprayed within a radius of 12.6 km (area 500 km^2) from each grid point was calculated and maps of insecticide utilization produced by contouring grid point totals. The intensity of insecticide utilization was converted to a "spray area ratio" to indicate the proportion of land treated with the quantity of insecticide purchased.

An area of 500 km^2 was selected for the summations of hectares sprayed after calculations over a range of radii, 5, 10, ... 50 km indicated that an area of 500 km^2 provided reasonable precision without extensive smoothing of map detail. Summations and grid calculations were conducted using original FORTRAN programs written for each purpose. These were undertaken for the most common insecticide products registered for grasshopper control: Furadan, Decis, Lorsban, Sevin XLR, and Cygon.

Identification of Geographic Overlap and Assessment of Risk

The geographic distribution of insecticide use in 1985 and 1986 was compared with the distribution of waterfowl and habitat variables for the same years. Survey segment estimates of waterfowl and pond densities and spray intensity were calculated and assigned to Voronoi map polygons. Voronoi maps of the results were produced and simple pair-wise correlations (Pearson's r) among the variables calculated using survey segment estimates of population and pond densities and spray intensity.

Voronoi mapping is a form of fixed polygon reporting in which the polygon boundary is placed according to the minimum distance between adjacent point locations. All territory within a polygon is closer to its central point than to any other point. Values associated with each point can then be applied to the corresponding polygon.

RESULTS AND DISCUSSION

Waterfowl and Habitat Variables

Densities of dabbling and diving ducks and broods were greatest in the aspen parkland ecoregion during all years of the study. Dry years were marked by dramatic declines in numbers in the grassland ecoregions and a retreat to suitable remaining habitat in the aspen parkland. May and July pond densities were greatest in the aspen parkland and forested ecoregions.

During the survey period dabbling duck densities declined by 60% from an average of 385 ducks per survey segment to 155. Diving ducks declined by 43% from an average of 72 to 42 diving ducks per survey segment. Brood densities declined by 74% from an average of 3.97 to 1.02 per survey segment. May pond densities declined by 42% from an average of 64 to 37 ponds per survey segment and July ponds by 33% from 18 to 12 ponds.

All pair-wise correlations of waterfowl and habitat variables had high significant positive correlations. Dabbling and diving duck densities were greatest where pond densities were greatest. Dabbling duck densities were strongly correlated with numbers of May ponds and diving duck densities with July ponds. Brood densities were also positively correlated with May ponds and to a lesser extent with July pond densities. Yearly number of July ponds were strongly correlated with numbers of May ponds. This data suggests that breeding waterfowl use spring wetland conditions as proximate clues for assessing summer wetland conditions.

Insecticide Spraying

Mapped results reveal that spray intensity (i.e., total ha sprayed divided by the area of the summation circle, 50,000 ha) was greatest for all insecticides in grassland ecoregions (1 to 5%). Spray intensity was typically less in the aspen parkland ecoregion (less than 1%). In general, the geographic pattern of purchase and application of insecticide corresponded to the distribution and abundance of grasshoppers. This relationship is not the subject of the present study, but indicates that predictive models of grasshopper population density and control requirements would be useful for anticipating and averting environmental impact, for example, by stocking and distributing alternative insecticide products.

Geographic Overlap and Assessment of Risk

Insecticide utilization tended to be negatively correlated or uncorrelated with waterfowl population density and the presence of ponds. Of the five insecticides surveyed only Decis had a small, but significant ($p < .01$) negative correlation with dabbling duck density. There were no other noteworthy significant correlations for dabbling and diving duck densities or brood densities.

The most significant correlations were those of pond density in May ($p < .01$). Regions with the greatest number of ponds in May tended to have lower insecticide utilization. These may be areas without high-value crops or without weather that leads to significant grasshopper control requirements, as indicated by lower number of grasshopper insecticide purchase.

Voronoi maps of survey segment waterfowl and insecticide variables show a tendency for the highest duck densities and the bulk of spraying to occur in separated regions. Waterfowl and pond densities were greatest in the aspen parkland ecoregion, whereas spray intensity was greatest in the grassland ecoregions. Some geographic overlap occurred in southern Alberta counties notably Warner, Willow Creek, Wheatland, Newell, and Vulcan.

The application of GIS technology is particularly well suited to identifying those locations where risk occurred and for characterizing the separation, although it cannot determine whether this separation is a result of differing weather patterns or of the impact of agricultural practices on wetlands. It is also important to note that geographic patterns and relationships may shift, and should be monitored and even anticipated if possible.

RECOMMENDATIONS

Recommendations for improving databases methodology include: 1) the GIS database developed for this study should be expanded through cooperation with other agencies involved in waterfowl population and habitat management to include Saskatchewan and Manitoba; 2) the insecticide database for Alberta could be improved with the incorporation of data from Wheat Pool counties and chemical corporations; attempts should be made to develop similar databases for Saskatchewan and Manitoba; 3) the GIS database should be applied to an economic study of the options potentially available to limiting the exposure of wildlife to insecticides, with the dual goals of protecting threatened wildlife and encouraging sustainable agriculture; and 4) the methods developed should be reviewed, finalized, and potentially adopted as a standard for comparisons of this type.

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LITERATURE CITED

Grue, C.E., L.R. de Weese, P. Mineau, G.A. Swanson, J.R. Forster, P. Arnold, J.N. Huckins, P.J. Sheehan, W.K. Marshall, and A.P. Ludden. 1986. Potential impact of agricultural chemicals on waterfowl and other wildlife inhabiting prairie wetlands: An evaluation of research needs and approaches. Trans. 51st N.A. Wild. Nat. Res. Conf. Pp. 357-383.

Mineau, P., P.J. Sheehan and A. Baril. 1987. Pesticides and waterfowl on the Canadian prairies: A pressing need for research and monitoring. ICBP Technical Publication No. 6. Pp. 133-147.

Strong, W.L. 1991. Ecoregions and ecodistricts of Alberta. Report prepared for Alberta Forestry Lands and Wildlife, Land Information Services Division. Edmonton, Alberta. 125 pp.

WILDLIFE-AGRICULTURE-INTEGRATED PRAIRIE FARM REHABILITATION ADMINISTRATION ACTIVITIES

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BACKGROUND

Both Canada's Green Plan (1990) and the 1990 Report of the Federal-Provincial Agriculture Committee on Environmental Sustainability (Agriculture Canada 1990) focus on eight sustainability issues that are considered most closely linked with natural resources and environmental quality. These eight main issues are: agricultural soil resources, surface and groundwater quality, water quantity, wildlife habitat, air and climate, energy, pollution and waste management, and genetic resources.

The committee's vision for the issue of wildlife habitat is that "Canada's agri-food sector and wildlife resources (are) to be managed for sustainability and long-term mutual benefits."

The Prairie Farm Rehabilitation Administration (PFRA) has a vested interest in wildlife and wildlife habitat because:

1. PFRA manages a large Crown land base (2.2 million acres) containing significant wildlife habitat resources.

2. PFRA promotes "sustainable use" of land and water resources; resources which wildlife relies on for habitat and agriculture relies on for food production.

3. PFRA promotes the concept that wildlife and agriculture can coexist with mutual benefits for both.

4. PFRA recognizes that farmers or other "habitat owners" may need compensation for their efforts to accommodate wildlife and wildlife habitat.

The objective of this paper is to describe a selection of PFRA's present activities which are mutually beneficial to agriculture and wildlife.

1. Canada-Saskatchewan Agreement on Environmental Sustainability

In 1990 Agriculture Canada introduced the Special Income Assistance Program which is an umbrella program providing producers up to $500 million in federal financial assistance. Under this program about $13 million in federal funds was allocated in 1991 to the Environmental Sustainability Initiatives (ESI) program across Canada.

Federal funding of projects includes $2.29 million in Saskatchewan, $1.77 million in Alberta and $0.6 million in Manitoba. These monies were matched by the provinces.

The Canada-Saskatchewan ESI agreement entails 55 federal projects and 24 provincial projects. Six federal projects relate directly to wildlife and wildlife habitat and 5 are outlined below (see Bristol, this volume for 6th).

1.1 Burrowing Owl (*Athene cunicularia*) Program - $1,350

This project aids an extension effort by the Saskatchewan Natural History Society to send out a newsletter to all Operation Burrowing Owl participating landowners informing them of general interest articles and requesting information on the annual count of Burrowing Owls. Another newsletter will be mailed out in 1992.

1.2 Carbofuran Use in Burrowing Owl Habitat - $8,100

This project's objectives were to heighten awareness of pesticide (Furadan) restrictions among landowners having Burrowing Owls on their land. The project also hopes to strengthen landowner contact with Operation Burrowing Owl and encourage sign up of new participants. As a result of the project over 50 new landowners signed up.

One hundred Saskatchewan landowners were administered a telephone questionnaire on Furadan use. Of the 100 landowners contacted, 35 had used Carbofuran at some time in the previous five years. Eighty-two percent were familiar with Burrowing Owls and 62% were familiar with the program Operation Burrowing Owl. Although 31% were partially aware of some restriction or of the toxicity associated with Carbofuran, not one person involved in the survey knew the exact restriction associated with the application of Carbofuran with respect to the Burrowing Owl. The results indicate the labelling restriction is ineffective in conveying the message that Furadan use may impact Burrowing Owl populations.

1.3 Pilot Habitat Retention Program - $78,650

The objectives of this project are to determine landowner preferred wildlife habitat retention options utilizing a landscape (Agro-ecological Resource Region) approach in the shortgrass prairie. The project was sponsored by the Saskatchewan Wildlife Federation who selected Western Resource Management Associates Ltd. of Yorkton to deliver the program.

The consultants are presently assembling various data bases (maps, soil survey, Crown land) and plotting existing wildlife habitat (uncultivated land). The project will also entail a mailout questionnaire directed at landowners in a select Saskatchewan rural municipality within this landscape region.

1.4 Management Plan for Douglas Provincial Park and Elbow PFRA Community Pasture - $5,000

Originally proposed by Parks Branch of Saskatchewan Natural Resources (SNR) the objective from SNR's point of view is to assess the current state of Douglas Park's vegetation and recommend future management actions. PFRA is interested in developing a management plan for Elbow Community Pasture which is part of the same landscape. The project has been contracted to Saskatchewan Research Council's Applied Plant Ecology Section. The studies' findings will be used by SNR and PFRA to decide how the rangeland can be managed in an integrated fashion to meet grazing, wildlife, recreation, and preservation needs (see Nykoluk, this volume).

1.5 Soil, Water, and Wildlife Degradation Exhibit - $20,000

This ESI project is one component of three-linked projects which will be integrated to form an agricultural display trailer. The three components include:

1. An Agricultural Resource Region Exhibit (Landscape Approach) - This exhibit is sponsored by the Saskatchewan Research Council and will provide a message that identifies the location and formation of agricultural resources. Resource history, soil and water cartography and technology will be highlighted.

2. A Soil, Water, and Wildlife Resource Display - Ducks Unlimited (DU) Canada is developing this exhibit which will convey the message that integrated agriculture requires improved efficiency and management of water resources. The exhibit will point out that farmers face a number of water management options which govern salinity, erosion, soil fertility, water cycling, crop and livestock production, and wildlife habitat.

3. An Integrated Agriculture Exhibit - The Saskatchewan Wheat Pool will provide this exhibit which focuses on the economic and social realities faced by farm producers over four generations. The key message will be that farmers care for the land and that sharing of resource responsibilities is required.

2. Integrated Range Management in PFRA Pastures

PFRA administers 2.26 million acres of range resources in 87 community pastures. In Saskatchewan at least half of the area in 62 pastures has been rated "critical" wildlife habitat by SNR. In addition, the PFRA pasture system provides space and resources for a variety of non-agricultural activities such as hunting, wildlife and landscape viewing, watershed protection, forest pulp cutting, mineral extraction, preservation of heritage resources, research and recreational parks.

PFRA presently integrates long-term range development and improvement strategies with wildlife concerns by passing its 5-year development plans to the provincial wildlife agency (SNR) for review. If there are serious conflicts, the two agencies seek alternative ways of addressing the needs of wildlife and livestock. Fifty-one pastures now have approved multi-use plans in various stages of implementation.

PFRA is involved in several projects that support the objectives of the North American Waterfowl Management Plan: waterfowl habitat enhancement in PFRA pastures; Permanent Cover Program and Prairie CARE (Conservation of Agriculture, Resources and the

Environment); inventory of waterfowl potential in PFRA pastures; and integrated pasture management in the Mount Hope, Prairie Rose, and Monet PFRA pastures (see Bristol, this volume for details).

2.1 Coalfields PFRA Pasture - Integrated Range Management

As an example, PFRA proposed shrub control in Coalfields PFRA pasture as a method to increase cattle carrying capacity. Since shrubs are an important component of wildlife habitat a conflict arose.

SNR and PFRA jointly developed a "go slow" experimental herbicide application which is being implemented by PFRA. Wildlife staff will attempt to identify what the impact of strip spraying is on Sharp-tailed Grouse (*Tympanuchus phasianellus*) and other wildlife habitat while PFRA will assess the herbicide application from the cattle and range production points of view.

2.2 Grazing Management in Suffield PFRA Pastures - Alberta

Tbe Suffield pasture in Alberta consists of three blocks of rangeland called: 1) Casa Berardi, 2) Koomati, 3) Queenston.

The Suffield situation is unique in that management relies upon mutual agreement by the Suffield Grazing Advisory Committee, the Department of National Defence Canadian Forces Base Suffield, and PFRA.

Current grazing management techniques to improve native grassland condition include: 1) rest-rotation grazing in the Casa Berardi block, 2) a three field deferred rotation in Queenston block, and 3) alternate water source development to relieve excess grazing pressure and erosion potential on the South Saskatchewan River breaks in the Koomati block pasture. Preliminary financial forecasts to fence out the river breaks are complete ($48,000).

Additional well development costs are estimated at $73,000. These grazing management strategies should improve the quality of wildlife habitat available in the Suffield complex.

3. PFRA - DU "Demo" Dugouts

In June 1990, DU and PFRA met to discuss joint projects to demonstrate improved water quality and enhanced waterfowl nesting success in and adjacent to dugouts. As a result, about 15 demonstration projects have been initiated on selected dugouts. Through PFRA's Water Development Section, DU will be supplied with names of clients constructing dugouts. DU will select cooperators from key waterfowl production areas and assist the farmer in preparing dugout plans. DU will promote levelling of spoil piles, seeding of grasses, fencing out dugouts plus buffer areas and pumping water for livestock. Farmer benefits should include improved water quality, lower dugout maintenance costs, and extended use of the dugout. Waterfowl benefits include improved waterfowl nesting opportunity and improved brood survival through improved brood salvage water.

4. Rare and Endangered Wildlife Species

The 1992 list of threatened and endangered wildlife species published by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) lists 230 species of mammals, birds, reptiles, amphibians, fish, and plants at risk. The PFRA pasture system provides some of the best remaining native habitat for many threatened prairie wildlife species.

Since 1984 PFRA has cooperated in the Swift Fox (*Vulpes velox*) release program by providing secure habitat in the Govenlock, Nashlyn, Battle Creek pasture complex in southwest Saskatchewan.

PFRA reviews its pesticide program annually to avoid negative impacts on species such as Burrowing Owls. Research has shown that Burrowing Owl nest burrows sprayed directly with carbofuran produced 83 percent fewer young (Fox et al. 1989).

PFRA is currently cooperating with other government agencies such as SNR and the Canadian Wildlife Service to identify critical habitats for rare and endangered species within the pasture system. PFRA is committed to maintaining the biological diversity of the landscape, especially on PFRA lands and will work with all land users to provide stewardship of endangered wildlife resources.

5. Shelterbelts for Wildlife - Save Our Soils (SOS) Program

Field shelterbelts are an integral part of soil conservation on the prairies because they reduce wind erosion. Shelterbelts also conserve soil moisture because they trap snow and reduce evaporation. Another reason for planting trees is to provide shelter and food sources (habitat) for wildlife.

Farmers and ranchers wishing to plant shelterbelts can request help in shelterbelt planning, design, and maintenance and can order tree and shrub seedlings free from the PFRA Shelterbelt Center at Indian Head.

Through the SOS program of the Canada-Saskatchewan Agreement on Soil Conservation financial assistance is also available for shelterbelt planting and maintenance. PFRA, SNR, and the SOS program jointly encourage landowners to consider wildlife when developing tree plantings in key target areas of southern Saskatchewan. In addition, shelterbelt centre staff travel to Manitoba to assist farmers in planning and design. In 1990, PFRA staff visited 44 landowners within target areas and 63 in other areas of Saskatchewan and Manitoba.

In 1991, PFRA distributed 11.83 million trees to applicants in Saskatchewan, Manitoba, Alberta, and the Northwest Territories. Trees distributed for special wildlife shelterbelts and block habitat plantings totalled 457,395 for Saskatchewan and Manitoba in 1992.

6. Rafferty-Alameda - Mitigation Plantings

The Rafferty-Alameda Water Conservation Project is basically complete. The Initial Environmental Evaluation (IEE) (Environment Canada 1989) presents information on environmental impacts affecting federal interests, identifies possible methods of mitigation, and identifies data gaps. The IEE predicted significant adverse environmental impacts on the Ferruginons Hawk (*Buteo regalis*) and Baird's Sparrow (*Ammodramus bairdii*) (threatened) and potential impacts on seven rare plant species. Provincial agencies also expressed concern over inundation of Sharp-tailed Grouse and White-tailed Deer (*Odocoileus virginianus*) habitat.

To mitigate for lost wildlife habitat, the Souris Basin Development Authority is working to purchase 61 quarter sections of land near the two reservoirs for the use of wildlife. In terms of size and the proportional amount of money to be spent, these mitigation measures are the largest ever undertaken in Canada.

The PFRA Shelterbelt Center at Indian Head was the logical source of plant material needed for the mitigation plantings (conversion of cultivated lands to wildlife habitat). As a result PFRA committed to enhancing cover on 31 quarter sections of land with an objective of converting 25-50% of each quarter to tree and shrub cover. Since 1988, 20 quarter sections have received treatment at Rafferty and 598,565 trees have been planted. Planting trials will also be initiated at Alameda reservoir in 1992 (35,000 trees).

The remainder of the mitigation lands will be seeded to grasses and shrubs on the basis of the habitat requirements of the wildlife species expected to use these lands. Hopefully, a native grass mixture can be seeded on some of these mitigation lands to improve biological diversity in the area.

7. The Future

Prairie people face a major challenge in bringing about a more sustainable or integrated agriculture. Attitudes and thinking must change. The caretakers of the land cannot deliver sustainability on their own. PFRA can play an ongoing and even greater role in integrating wildlife and agriculture on the landscape for enjoyment now and for future generations of Canadians.

LITERATURE CITED

Agriculture Canada. 1990. Growing Together. Report to Minister of Agriculture Federal-Provincial Agriculture Committee on Environmental Sustainability. Ottawa.

Environment Canada. 1989. Rafferty-Alameda Project. Summary report of the Initial Environmental Evaluation for Environment Canada. Conservation and Protection, Regina.

Fox, G.A., P. Mineau, B. Collins, P.C. James. 1989. The impact of the insecticide carbofuran (Furadan 480F) on the Burrowing Owl in Canada. Technical Report Series No. 72, Canadian Wildlife Service, Ottawa.

Government of Canada. 1990. Canada's Green Plan. Minister of Supply and Services Canada. Ottawa. 174 pp.

PRAIRIE FARM REHABILITATION ADMINISTRATION, COMMUNITY PASTURE RANGELAND INVENTORY, AND RANGE SITE BENCHMARK ESTABLISHMENT

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The world conservation strategy has identified three global objectives for living resource conservation, and they are to: 1) maintain essential ecological processes and life support systems; 2) preserve biological diversity; and 3) to ensure the sustainable use of species and ecosystems (World Wildlife Fund 1988).

Since these global objectives must be recognized at the national, regional, and local levels, the establishment of the Prairie Farm Rehabilitation Administration (PFRA) community pasture range site benchmark reference areas will contribute in a proactive matter towards this very meaningful world wide initiative. The establishment of these areas is also congruent with the concept of "think globally and act locally." These reference areas will provide a valuable basis for a prairie rangeland ecosystem conservation strategy which was identified in the Prairie Conservation Action Plan.

According to the Flora and Fauna Advisory Group report of March 1991, there are 81 nationally rare vascular plants for Canada occurring in Saskatchewan alone. Hence, an ecological reference area such as the establishment of a range site benchmark for a specific "potential natural plant community," is in our view an important attribute of PFRA ongoing rangeland inventory activities to assess, measure, and monitor the ecological status of our natural grasslands under certain livestock grazing management practices.

The decision to select any range management alternative requires the ability to recognize and predict any possible changes that will result from different management applications under different environmental conditions. Therefore, the PFRA community pasture program recognizes the need for rangeland biophysical inventory information as a basic prerequisite in the conservation, management, and planning of our rangeland resources in western Canada.

A range site benchmark is defined as a permanent reference point, in range inventory, that is used as a point where changes in vegetation through time are made (Kothmann 1974).

The range site (or ecological site benchmark project) is part of our ongoing rangeland inventory work in the evaluation of native range condition, the "apparent" and "measured" trend, (directional changes in secondary succession), and the potential above-ground biomass productivity for a specific plant community association.

Livestock grazing is a biotic process, and it is one of the driving variables which often has a significant impact upon natural plant community development. Hence, the basic range management objective is to identify and quantify these changes from an ecological perspective. We must be capable of modifying our livestock grazing management practices (i.e., seasonal stocking rate adjustments, implementing grazing systems, etc.), based on the current seral stage of natural plant associations.

The selection and establishment criteria for PFRA range site benchmarks have been standardized in Saskatchewan along with other agencies. They are as follows:

1. The site should be one hectare in size, and representative of a particular range site or (habitat type) in "undisturbed" condition.

2. The site should contain the potential natural plant community for that specific site. It must be stable and expected to remain undisturbed over the long-term.

3. The site should be of representative landform, soil type, slope, etc.

4. A two-way exclosure is required to protect the benchmark site from livestock grazing; wildlife use is allowed.

5. The site should be in close proximity to a weather data collection station.

6. The site should be accessible for use in demonstrations and as a teaching tool.

7. The site should be in close proximity to grazed areas.

The data collection of range site benchmarks consists of the following elements:

1. Benchmark name and location description.

2. Physical description of each site including: soil surface texture, parent material, soil profile, and soil chemical analysis.

3. History of the site including: degree of past use/non-use, evidence of fire, and insect activity.

4. Vegetation including: plant species composition, % of ground canopy cover, litter cover, above ground biomass productivity, and frequency of species occurrence.

A data storage and retrieval system has been established. A personal computer database system has been set up, and data entry for transect information will be completed by the range management staff each year. Range site benchmark data are then correlated on the basis of plant species composition, production of the potential plant communities, and soils.

In conclusion, it is our view that native prairie rangeland under livestock grazing can be best managed from an ecological perspective. Range site reference areas can provide us with essential information in the evaluation and monitoring of our rangeland ecological status. It will enhance our ability to manage this very important resource in Western Canada.

LITERATURE CITED

Flora and Fauna Advisory Group. 1991. Advisory Group Report. Saskatchewan Round Table on Environment and Economy. Regina, Saskatchewan.

Kothmann, M.M. 1974. A glossary of terms used in range management. 2nd ed. Society of Range Management. Denver, Colorado.

World Wildlife Fund Canada. 1988. Prairie Conservation Action Plan 1989-1994. World Wildlife Fund, Toronto, Ontario, Canada.

WORKING TOWARDS MULTIPLE USE MANAGEMENT ON PRAIRIE FARM REHABILITATION ADMINISTRATION COMMUNITY PASTURES

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To set the stage for our workshop today, I would like to present a brief overview of: Prairie Farm Rehabilitation Administration's (PFRA) community pasture rangeland resource, PFRA's mandate, and a description of our Environmental Assessment and Review Process.

I would also like to relate to you a few of our experiences in working towards achieving our goal of multiple use management on PFRA community pastures.

Today PFRA community pasture lands total 913,916 hectares (or 2,258,286 acres). This is equivalent to an area of 95.5 km^2. There are 87 community pastures across the three prairie provinces: 62 in Saskatchewan, 24 in Manitoba, and 1 in Alberta. The average pasture size is about 10,000 hectares. Many of these pastures came into operation in the 1930s and 1940s and our mandate ensures that wise use of the resource shall prevail in the long-term. PFRA has a proactive commitment to the protection and management of wildlife habitat on its rangelands. Indeed, this habitat exists today because of the long-term range management program PFRA has administered. A recent inventory of the PFRA rangeland resource has revealed that over 80% of our land base is composed of native vegetation (Cook 1991, pers. comm.).

To gain an appreciation of what PFRA has been up to for the past 54 years or so, a look at our federal mandate is essential. Our mandate consists of 2 broad objectives: conservation and summer grazing for cattle.

OBJECTIVE 1: CONSERVATION

To make possible land use activities that are compatible with the production capabilities of the soil and to facilitate improved land use through rehabilitation, conservation, and management of the rangeland resource.

Principles

It is understood that:

1. Permanent vegetation cover will be established and maintained on pasture lands recognizing the value of native vegetation and the role of trees, shrubs, and domestic forages in providing a diverse plant community within the landscape.

2. The resources will be managed in a holistic fashion to ensure a viable, productive, and sustainable ecosystem.

3. Compatible agricultural and non-agricultural use will be made of the resources.

Goals

1. To facilitate suitable land use.

2. To promote responsible resource management and ensure sustained productivity.

3. To provide stable, long-term management which combines protection, development, improvement, and utilization of the resources.

OBJECTIVE 2: SUMMER GRAZING FOR CATTLE

To utilize the resource primarily for the summer grazing of cattle while assisting in stabilizing small farms and providing breeding bulls to encourage high quality, long-term cattle production.

Principles

It is understood that:

1. These lands should remain productive and are to be used primarily for agricultural purposes.

2. Through the provision of grazing on these lands, agricultural diversification and the opportunity for mixed farming and thus maximization of opportunities on patron land can be facilitated.

3. Proximity to the pasture will be used as an eligibility criteria.

4. Grazing privileges will he allocated in a way that will afford all eligible applicants reasonable utilization of the rangeland resources.

5. Responsible livestock and range management practices will be utilized and promoted.

Goals

1. To use the resource primarily for the summer grazing of livestock.

2. To stabilize economic conditions and diversify farming operations in rural areas.

3. To maintain the rangeland ecosystem, which evolved with ungulate grazers, by the use of domestic livestock.

FEDERAL ENVIRONMENTAL ASSESSMENT REVIEW PROCESS

PFRA has made the following arrangements to ensure proper planning, assessment, and environmental acceptability of community pasture development proposals. In Saskatchewan, PFRA identifies all proposed range developments to the Department of Saskatchewan Natural Resources (SNR), well in advance of construction. Impacts on critical wildlife habitat, fragile prairie ecosystems, and wildlife populations are determined, and plans are modified where necessary. Where significant adverse environmental impacts are identified, the proposal is assessed in more detail, and may be modified, and in some cases, abandoned.

A similar procedure is followed for development planning on community pastures within the Province of Manitoba. Consultation, cooperation, and exchange of information takes place with tbe Wildlife Branch, Manitoba Environment, Crown lands, and the Forestry Branch.

Within Alberta, PFRA operates one community pasture on the Canadian Forces Base Suffield. A Suffield Grazing Advisory Committee has been established under a Memorandum of Understanding between PFRA and the Department of National Defence. The purpose of the committee is to ensure that the pasture receives proper range use consistent with the conservation of lands subject to grazing. Committee members include representatives from each of Agriculture Canada, Canadian Wildlife Service, Alherta Forestry Lands and Wildlife, and Alberta Agriculture. PFRA is not a member of this committee.

This multi-disciplinary pasture planning process has evolved over several years, based on our range management experience, and the cooperation and valuable advice received from cooperating wildlife agencies. We feel that this process is effective, because the site specific assessments provided by conservation officers, field ecologists, and range management staff provide us with detailed knowledge of the resources intended for development.

MULTIPLE USE MANAGEMENT

The road towards achieving multiple use management on PFRA community pastures has not always been an easy one, and we recognize that there is still a lot of work to do. Nonetheless, working with different agencies is a welcomed challenge.

We recognize the need for "in house" expertise. We must be able to interpret available scientific literature, and be able to communicate with cooperating agencies whose mandates differ from ours. PFRA has acquired a wildlife habitat biologist and a waterfowl biologist. In the last year PFRA has been able to increase its Range Management staff in the Pasture Planning Section. Agencies who work with us must be able to understand PFRA's goals and objectives, and they must believe that the integration of livestock and wildlife interests is possible. An element of trust and understanding must be developed through sincere efforts at communication. Cooperative programs and projects necessitate that more people be involved, and more time be spent in the decision making process. This means that it takes a lot more time to get things done.

There is a need for more information on the habitat requirements of various wildlife species on PFRA community pastures, and wildlife/livestock interactions. There is also a need for more information on habitat management, as opposed to preservation of habitat.

Rangelands are dynamic in nature and they have evolved under extreme influences such as fire, drought, insects, and overgrazing. Historically, aboriginal man used fire as a means of attracting the American Bison (*Bison bison*), so there are also anthropogenic influences. Grasslands co-evolved with both grazers and browsers, and domestic cattle provide an ecological substitute for bison. Preservation alone will remove many of the biotic factors that have shaped rangelands as we know them today. There is already considerable research that suggests that ungrazed rangelands are not as diverse and productive. The loss of grasslands to shrub encroachment that we have seen all over North American rangelands, may be due in part, to man's control of fire.

PFRA operates its pasture program on a "user pay" cost recovery basis, through fees for services such as grazing, breeding, and mineral extraction. If other interest groups wish to initiate environmental projects, then financial and personnel resources will have to be provided for planning, implementing, maintaining, and monitoring cooperative projects. Agricultural users are not the sole benefactors on PFRA community pastures, and therefore, should not be expected to pay for these non-agricultural initiatives. I am pleased to say that PFRA has chosen to be proactive on wildlife matters instead of reactive, and here are just a few of the initiatives that we have undertaken.

PFRA pastures have hosted numerous Ducks Unlimited (DU) water projects through the years, and as you will hear later this afternoon, PFRA and DU staff have been working together to develop planned grazing systems that will benefit waterfowl and range condition. We hope to have two of our pastures operating on such systems during the next grazing season, and we plan to continue these types of projects.

We have been working with the Saskatchewan Research Council and SNR on a vegetation management study for the Elbow Community Pasture, and the adjoining Douglas Provincial Park. We are trying to determine the impact of ungulates, fire, and drought, on a sensitive sand dune complex. In addition, this year we undertook a project utilizing sheep for the biological control of Leafy Spurge (*Euphorbia esula*) at the Elbow Community Pasture.

A multiple use management plan was initiated at the Coalfields Community Pasture. Participating agencies included SNR staff and PFRA shelterbelt and range management staff. This project was most valuable in terms of setting up the multiple use concept for the community pasture program.

We are also developing our extension initiatives—we will be offering increased education on different aspects of range management to both the general public and our own range management field staff.

In closing, I hope that I have been able to give you a picture of how PFRA approaches multiple use management on community pastures, through the mandate of one of Canada's oldest soil conservation programs. We hope that any agencies or groups who would like to work with us will feel welcome to do so. We feel that partnerships will continue to be the most efficient way to ensure that all conservation objectives are met.

WATERFOWL FRIENDLY PLANS AND PROGRAMS IN PRAIRIE FARM REHABILITATION ADMINISTRATION PASTURES

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Recently Prairie Farm Rehabilitation Administration (PFRA) has become involved with a number of wildlife-agriculture integrated activities. The activities that relate directly to waterfowl include the following.

1. PFRA AND THE NORTHERN AMERICAN WATERFOWL MANAGEMENT PLAN (NAWMP)

1.1 Waterfowl Habitat Enhancement in PFRA Pastures

In February 1991, the Saskatchewan Wetland Conservation Corporation (SWCC) invited PFRA to submit a waterfowl habitat proposal for possible NAWMP funding. Under the NAWMP guidelines, Canadian applicants can submit project proposals for funding through the 1989 United States Congress North American Wetlands Conservation Act. United States federal grant monies are matched with other United States and Canadian funds to secure, develop, enhance, or manage wetlands in Canada. In May 1991, PFRA presented a six year $3.24 million proposal to SWCC for implementation under NAWMP starting in 1992 (Weins 1991). The proposal contained the following elements for development:

1. Design and implementation of integrated wildlife friendly range management plans on 21 PFRA pastures within NAWMP program areas.

2. PFRA acquire a NAWMP funded wetland team to develop an inventory of waterfowl habitat and design management plans that are beneficial to waterfowl and range management.

3. PFRA acquire NAWMP funded personnel to manage the integrated range plans.

This proposal bas been approved in principle. The funding and delivery of this proposal has been incorporated into the Ducks Unlimited (DU) Delivery System. Also PFRA and DU are developing demonstration dugouts to improve water quality and enhance waterfowl nesting sncccss (see Weins, this volume).

1.2 PFRA - Permanent Cover Program (PCP) and Prairie CARE (Conservation of Agriculture, Resources and the Environment)

A PCP was first offered under the three year National Soil Conservation Program for Alberta and Saskatchewan in 1989. An enhanced program (PCP II) for all three prairie provinces was introduced in 1991 under the Farm Support and Adjustment Measures Program. PCP II is designed to meet the environmental sustainability goals outlined in the Agriculture Policy Review and the Green Plan (Anonymous 1991).

Prairie CARE is the major program component of an overall strategy offered under the NAWMP, and is delivered on behalf of the plan's partners by DU Canada, the SWCC, Alberta Forestry, Lands and Wildlife, and the Manitoba Habitat Heritage Corporation. Prairie CARE is designed to promote a land stewardship or land ethic that will change agricultural management practices so that wildlife can exist in harmony with agriculture.

PFRA is both the delivery agent for PCP programs and a member of the Prairie Habitat Joint Venture Advisory Board which endorses and evaluates NAWMP programs. The PCP programs and Prairie CARE are integrated because putting cover back on the land not only prevents soil and water degradation but also provides enhanced wildlife habitat.

Landowners eligible for PCP II may also qualify for additional money under option 2 of this program. This option targets specific rural municipalities in NAWMP program areas; land is leased for exclusive use by wildlife. Participating landowners will receive grass seed suitable for nesting cover, plus an annual lease payment following stand establishment. By the end of December 1991, 5,900 applicants were committed to the program. Expenditures totalled $30.5 million and covered 485,000 acres.

2. CANADA-SASKATCHEWAN AGREEMENT ON THE ENVIRONMENTAL SUSTAINABILITY INITIATIVE (ESI)

This $13 million agreement was signed in 1991. Its aim is to assist the agri-food industry achieve environmental sustainability. The agreement covers a range of projects that support effective resource management and environmentally sustainable agricultural practices.

The Canada-Saskatchewan ESI agreement includes fifty-five projects. Six of these projects relate directly to wildlife and wildlife habitat.

One of the six projects is to conduct an inventory of waterfowl habitat in PFRA pastures. To complete this project, PFRA has retained the services of a waterfowl biologist for a 1-year term. The objectives are: 1) to initiate an assessment of existing wetland habitat and waterfowl use on six of twenty-one PFRA pastures that are within NAWMP program areas; 2) to priorize the pastures for waterfowl habitat management; 3) to design planned grazing systems for those pastures having potential for waterfowl production; 4) to assist PFRA and DU with implementation of planned grazing systems; and 5) to assist PFRA and DU in planning and developing 1992 NAWMP funding proposals and to recommend where the NAWMP evaluation program could be incorporated to monitor waterfowl production with respect to planned grazing systems.

3. INTEGRATED PASTURE MANAGEMENT - MOUNT HOPE-PRAIRIE ROSE PASTURE

In 1987 PFRA and other NAWMP partners developed a study proposal to enhance waterfowl habitat and sustain forage production for the Mount Hope-Prairie Rose Pasture in east-central Saskatchewan. In January 1991, PFRA and DU signed an agreement for a cost-shared project to implement a rotational grazing system. The objectives include improved waterfowl nesting success due to improved residual cover and reduced disturbance during waterfowl nest initiation. As well it will improve the current pasture condition by distributing the cattle more evenly over the entire pasture, reducing selective grazing by livestock and allowing periods of rest during the active growing season.

The development plan involves subdividing the current ten field pasture into 21 grazing cells. This required the construction of 22 miles of solar powered and suspension fencing. Additional water developments were also required to complete the system. Nine new well sites were developed to ensure that stockwater supplies would be adequate during drought conditions.

The management plan, which will be implemented in 1992, has five rotational grazing units. Each contains four fields that will be grazed in rotation and one field that will be continuously grazed (this will act as a control). The cattle will graze in the first field until early July and then be moved through the remaining three cells for the balance of the grazing season.

4. INTEGRATED PASTURE MANAGEMENT - MONET PFRA PASTURE

Monet is the highest ranked PFRA pasture of the six sites investigated as part of the waterfowl inventory conducted in 1992. It is located in west central Saskatchewan in the northern part of the Missouri Coteau. The development plan is scheduled to be implemented in 1992/1993. Improvements include 24 miles of suspension fence and development of eight new water sites. Range management includes a change from continuous grazing to a deferred rotation grazing system. Benefits include improved upland nesting habitat (due to improved residual cover), reduced disturbance during nest initiation, improved livestock distribution with less selective grazing, and overall improved range condition.

The pasture will be divided into five grazing units, depending on breed of cattle or breeding condition. Each unit will have from four to seven smaller fields that will be grazed once per year. Two fields currently in tame Crested Wheat Grass (*Agropyron cristatum*) will be fenced separately from the native pasture and will be utilized for early season grazing. This serves to defer grazing of native range in two of the units and concentrates the grazing pressure in poor quality waterfowl habitat. The cattle are then moved into each of the native fields in rotation. Grazing period is dependant on field size, number of fields in the unit, and forage availability. This system ensures that at least three fields in each unit will remain undisturbed until after peak nest initiation by waterfowl occurs in the latter part of June.

In summary, I will say that the focus of this individual presentation has been directed specifically at improvements for waterfowl. However, if we consider integrated resource management for agriculture and wildlife, many wildlife species found within the pastures will benefit from projects such as these.

LITERATURE CITED

Anonymous. 1991. Permanent Cover Program II in Saskatchewan, Prairie Farm Rehabilitation Administration, Publication PFP0046 Supply and Services Canada, Ottawa, Ontario.

Weins, T. 1991. Wildlife-Agriculture Integrated PFRA Activities. Unpublished report. PFRA, Regina, Saskatchewan.

RESTORING NATIVE PRAIRIE ECOSYSTEMS

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INTRODUCTION

This is the first session on prairie restoration to be held at the Prairie Conservation and Endangered Species Workshop. It is likely also one of the first sessions on this topic in Canada. For many years we have been talking about and working on components of the prairie ecosystem; the individual species that make up the prairie landscape. Endangered species recovery plans, management plans targeted at specific groups of plants or animals all receive considerable attention. But the native prairie itself, the very basic habitat that all prairie wildlife depends upon, has been largely ignored.

OBJECTIVES

The objectives of this workshop are: 1) to determine what prairie restoration is; 2) to examine why prairie restoration is needed; 3) to explain the importance of prairie restoration using locally collected native seed; 4) to examine the mechanics of restoring native prairies; 5) to identify information needs for more effective prairie restoration in Canada; 6) to present some case studies of actual prairie restoration projects; 7) to establisb a network of people practising prairie restoration so that information can be better shared in the future; and 8) to generate an action list of what needs to be done in prairie restoration in Canada between now and 1994.

DISCUSSION

The art of prairie restoration is in its infancy in Canada. Notice that I said "art" not science, for there is very little scientific basis for anything that we do in prairie restoration in this country. Things are somewhat different in the United States where prairie restoration projects have been ongoing for many years. Even in the United States, however, there are very few scientifically based studies of restoration ecology. Most information is still anecdotal or in the heads of a few key people. Much of it is specific to conditions quite different than those on the Canadian portion of the continental prairie.

We can learn a lot from the American experience, and from conventional knowledge in the agricultural and reclamation sectors. Particularly in regard to site preparation, pre-planting weed control, and equipment needs, this expertise is very valuable. When it comes to harvesting native ecotypes, species selection, weed management, and ecological succession in restored prairies, we are in need of developing better information specific to the types of prairie found in Canada.

In the absence of a better definition, let's say that authentic prairie restoration involves the planting of a diverse mix of species native to that particular area, with the seed collected as close as possible to the planting site. Grasses are an important component of the mix, but equally important are various native legumes and other forbs (wildflowers). Local seed stocks (what ecologists call "ecotypes") are important in maintaining the biological diversity and adaptability inherent in any natural population of plants.

It might help to understand what prairie restoration is, by saying what it is not. Prairie restoration is not simply planting grass. To the average person and even many professional resource managers, one stand of "grass" is the same as any other. I seriously question the view that a stand of Alfalfa (*Medicago sativa*) - brome (*Bromus* sp.) or Crested Wheat Grass (*Agropyron cristatum*) is equivalent to, or even resembles, a native prairie. Even a stand of so-called "native" grasses that were originally taken from a limited number of wild stock ancestors, selected for genetic uniformity and ease of germination, released as a commercial cultivar, and then planted hundreds or thousands of kilometres from their point of origin, is not a prairie restoration.

In addition, prairie restoration is not a substitute for conserving existing native prairie areas. Just because we say we think we know how to recreate a prairie, does not give us an excuse for becoming less vigilant in maintaining existing native areas. As anyone who has ever tried to restore a prairie knows only too well, restoration is a difficult, time-consuming, and expensive process. There is no substitute for maintaining, conserving, and managing existing native prairie areas.

In our lifetime at least, even the best restored prairie will only be an approximation of the real thing.

ACTION LIST

For prairie restoration to become more than just a dream in Canada, several things are needed. Firstly, we need more detailed research on the mechanics of restoring the variety of prairie community types. What works in the moist black chernozemic soils of Manitoba's Red River Valley, for tall grass prairie may be quite different than what is needed for the dry short grass prairies of southern Alberta. Research similar to the Tall Grass Prairie Restoration Project is needed for mixed grass, short grass, rough fescue, and sandhill prairie communities. At least three permanent plots in each prairie type should be set up and assessed to determine optimal methods of restoring those prairie types.

Secondly, better methods of weed control need to be developed for all types of prairie restoration. One of the most serious problems faced by restoration professionals is competition with non-native weeds in the initial stages of the prairie planting. Prairie plantings, involving mixtures of slow growing, perennial grasses and broadleaved plants, many of which have quite variable germination rates, confer unique weed control problems. An integrated approach involving cultural, chemical, and biological control methods needs to be researched and developed in consultation with agronomic weed control experts.

Thirdly, additional sources of local ecotypes of native prairie seed need to be developed. At present, there is only one producer of native seed in all of western Canada. With a growing interest in native prairie restoration, the conservation of biological diversity, and restoration projects like Grasslands National Park, the demand will continue to increase. Rather than import large quantities of non-local ecotypes from the United States, we should be developing several of our own native seed sources for each prairie type.

Lastly, there needs to be greater awareness of the techniques and importance of authentic prairie restoration among professional resource managers, wildlife biologists, public land managers, and society as a whole. Production of a prairie restoration manual, with details of how to restore and manage the variety of prairie types would be very useful. It would greatly increase the success of efforts to restore our endangered prairie heritage.

HIDDEN VALLEY RESTORATION PROJECT

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After finding that a portion of its 320 acre wildlife sanctuary at Regina, Saskatchewan had been breached by the plough, the Regina Natural History Society recommended that the land cultivated, approximately 4.4 acres, be returned to a native prairie. It was also felt that this would provide an excellent opportunity to monitor the vegetation as it returns back to a natural state.

The project of restoration began in the fall of 1989. Time was spent in determining the size of the project, the costs, and where the personnel and financial support will come from.

METHODS

The project began with the knocking down of the weed growth. This was done in the early fall of 1989. The second step was the seeding of three native grasses—Streambank Wheat Grass, Sodar variety (*Agropyron riparium* Scribn & Sm.), Northern Wheat Grass, Clark variety (*Agropyron dasystachyum* (Hook.) Scribn.), and Slender Wheat Grass, Revenue variety (*Agropyron trachycaulum* Gaertn.). These were supplied by the Saskatchewan Wheat Pool. There was no harrowing after the seeding. It was allowed to fall down onto the ground as it may do naturally. This seeding was done in the fall of 1989 by Frank Switzer and his son, Ian.

Beginning in the spring of 1990, a weekly survey of the entire area was initiated. The number and species of plants within 20 0.5-metre squares were tabulated weekly. These 20 sample areas were identified in as random as possible a method. This method included general wandering and the throwing out of a wire square. These samples began on May 10 and ended on July 12 since there will be little change in number or species occurring after that date.

In addition to the 20 samples, eight 5-metre transects between the cultivated and uncultivated part of the sanctuary were identified. The transects were spread around the perimeter of the plot. The transects were reviewed and plants were identified along a quarter metre corridor along both sides of the transects. The transects were split equally between the cultivated and uncultivated ground. This was done to view if there was any incursions by native species into the project area during the year.

In order to identify the potential invaders of the cultivated plot, a photographic record of the flowers and grasses within the sanctuary was taken. Species were keyed using recognized taxonomic references (Looman and Best 1987, Spellenberg 1979, Peterson and McKenny 1975).

RESULTS

The primary result of the monitoring was the identification of 17 species that grew in the project area (Table 1). These include, principally, Wild Oats (*Avena fatua*), Aspen Poplar (*Populus tremuloides*), Smooth Aster (*Aster laevis*), Broomcorn Millet (*Panicum miliaceum*), and a species of mustard. There was no movement of native species into the cultivated restoration plot. Wild Oats was the predominant species of the plot (Table 1) but no management of this species was initiated.

The Aspen Poplar seedlings were first noted in the sample areas on May 31, 1990 approximately 30 metres away from the edge and the nearest trees.

On July 5, 1990, a clump of Smooth Asters was noted on the southern side of the plot.

Throughout the entire plot, there was a number of other typical field weed species found dominant on the plot. These included Broomcorn Millet, Tansy Mustard (*Descurainia richardsonii*), Russian Thistle (*Salsola kali*), Red-root Pigweed (*Amaranthus retroflexus*), Lamb's-quarters (*Chenopodium album*), Common Wild Rose (*Rosa woodsii*), Field Toad-flax (*Linaria canadensis*), Field Chickweed (*Cerastium arvense*), and Wild Mustard (*Brassica kaber*) (Table 2).

DISCUSSION

There was insufficient movement or change in the transect samples to determine if change in the border between the cultivated area and the native prairie occurred.

Table 1. Average density of plants species (plants per m^2) found in 20 - 0.5 m^2 plots, on the Hidden Valley Restoration Project on July 12, 1991.

Plant No.	Species	Density
1	Red-root Pigweed (*Amaranthus retroflexus*)	20.2 (1)
2	Smooth Aster (*Aster laevis*)	- (2)
3	Wild Oats (*Avena fatua*)	487.6 (1)
4	Wild Mustard (*Brassica kaber*)	30.4 (1)
5	Shepherd's Purse (*Capsella bursa-pastoris*)	- (2)
6	Field Chickweed (*Cerastium arvense*)	0.8
7	Lamb's-quarters (*Chenopodium album*)	0.4
8	Tansy Mustard (*Descurainia richardsonii*)	6.2 (1)
9	Field Toad-flax (*Linaria canadensis*)	1.0
10	Alfalfa (*Medicago sativa*)	- (2)
11	Broomcorn Millet (*Panicum miliaceum*)	310.2 (1)
12	Aspen Poplar (*Populus tremuloides*)	1.2 (3)
13	Russian Thistle (*Salsola kali*)	4.2 (1)
14	Prickly Sow-thistle (*Sonchus asper*)	- (2)
15	Stinkweed (*Thlaspi arvense*)	- (2)
16	Goat's-beard (*Tragopogon pratensis*)	- (2)
17	Vetch (*Vicia* spp.)	- (2)

(1) These were the most abundant, most frequently found and some of the most commonly found agricultural weed species in the project area.

(2) These species were not found in the sample taken on July 12 but were found in the project area at least once through the summer season.

(3) This species was found in an area approximately 30 metres away from other plants of the same species adjacent to the project area.

After identifying the species that are present on the project area and the likelihood that these species will continue to be found on the area due to the disturbance, it is suggested that there be some means of controlling some of these species, especially the Wild Oats. This management should only be the control of the seed production through harvesting the plant such that no seed has a chance of dropping to the ground. Over time, the seeds already present in the soil will germinate and be depleted. This management will also allow the other grass species to out compete the wild oats and eventually reduce its dominance within the project area. An alternate strategy is to conduct no seed management to see if Wild Oats can maintain itself or if other species will replace it.

It also should be noted that none of the seeded grasses were found in the samples over the summer. This could be due to the slow nature of grass germination and the small size of the sample taken. It is speculated that these grass species will be more prominent on the project area in time.

This project of restoration of native prairie is a long-term program and should not be wholly discounted for not getting immediate results. A valuable baseline of information was obtained in the first year.

Table 2. Plant Species and density (Number per m^2) found by regular sampling of 20 plots on the project area.

Plant[1] No.	May				June				July	
	10	16	24	31	6	14	21	28	5	12
1	11.8	8.4	6.4	11.8	29.4	7.4	19.6	13.6	16.2	20.2
2	-	0.2	0.2	-	-	-	-	-	-	-
3	62.4	195.8	292.4	361.2	12.8	-	-	-	522.2	487.6
4	-	-	39.6	34.6	20.2	20.6	30.8	20.6	36.8	30.4
5	17.6	18.8	0.4	-	-	0.2	-	-	-	-
6	-	-	-	-	0.4	-	0.6	0.2	0.2	0.8
7	0.2	-	0.2	-	-	-	0.2	0.2	0.2	0.4
8	6.6	21.8	23.8	17.4	13.8	21.2	11.6	12.0	17.8	6.2
9	-	-	-	-	-	-	0.6	-	0.2	1.0
10	-	-	-	-	-	0.2	-	-	-	-
11	-	1.8	112.2	74.6	116.0	59.2	160.0	141.4	75.2	310.2
12	-	-	-	1.6	0.2	-	0.8	0.4	0.2	1.2
13	1.0	0.2	1.2	0.4	0.2	0.8	0.2	4.8	2.6	4.2
14	-	-	-	-	-	-	-	-	0.2	-
15	-	-	0.2	0.8	-	-	-	-	-	-
16	-	-	-	-	-	0.2	-	-	-	-
17	-	-	0.2	-	-	0.2	0.4	-	-	-

[1]See table 1 for species names

ACKNOWLEDGMENTS

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LITERATURE CITED

Looman, J. and K.F. Best. 1987. Budd's Flora of the Canadian Prairie Provinces. Agriculture Canada Publication 1662, Ottawa.

Petersen, R.T. and M. McKenny. 1975. A Field Guide to Wildflowers of Northeastern and North-central North America. Houghton Misslin, Boston.

Spellenberg, R. 1979. The Audubon Society Field Guide to North American Wildflowers, Western Region. Alfred A. Knopf, Inc., New York.

MIDWEST RESTORATION HISTORY

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The goat prairie on the southwest facing slope behind my dad's barn still exists! As a child in the '50s, my parents warned me not to hike the hill because the sunny, rocky, sandy bluff was home to rattlesnakes. In my years of scampering up the hill, I never saw a Prairie Rattlesnake (*Crotalus viridus*). I suspect they heard me coming as I whistled a happy tune. My climbs were rewarded with Pasque Flowers (*Anemone patens*), Common Wild Roses (*Rosa woodsii*), and Blue-eyed Grass (*Sisyrinchium montanum*), depending on the season. I knew it was a special place; I did not know it was a prairie. Thirty-five years later I returned to see if my childhood memory had survived. Not only was it there, but it had expanded on the slopes where grazing had been eliminated! As in the years before, I saw no rattlesnakes.

I found great hope from that recent experience for what has become my career—plant community restoration. Let me explain how restoration has evolved since those childhood days in the midwest.

Representative of restoration in the decades since my childhood are:

1. 1930-1940s - Ecologists Aldo Leopold and John T. Curtis began planting an educational sampler of Wisconsin plant communities at the University Arboretum. Their prairie restoration is the oldest known attempt to recreate a prairie community.

2. 1950-1960s - Other ecologists, including Peter Schram of Knox College in Galesburg, Illinois described do's and don'ts of prairie restoration and hosted the Prairie and Prairie Restoration Symposium of 1970 which has been followed by the biennial North American Prairie Conference meetings.

3. 1970s - Landscape architects, like Darrel G. Morrison, began to apply ecological findings to their residential/commercial design work. This was a logical link to a landscape architect Jens Jensen, of the early 1900s, who used nature as a model for his work.

4. 1980s - Restorationists, like Ron Bowen of Prairie Restorations Inc., began to emerge due to the demand for practical environmentalism. During this decade the Society for Ecological Restoration, a nationwide group, was begun.

5. 1990s - My own work pulled together the work of all my predecessors, from residential, to educational, to practical roadside application at the Minnesota Department of Transportation (DOT). Other DOTs including Iowa, Wisconsin, Michigan, and Illinois did similar work.

All of these states share parallel roadside history based on the following events:

1. 1960s - The 1965 roadside beautification legislation during the Johnson administration meant that billboards and junkyards would be removed from the landscape and plantings would be added. In his support of restoration, President Johnson stated "Our land will be attractive tomorrow only if we organize for action and rebuild and reclaim the beauty we inherited."

2. 1970s - Roadside management shifted toward an ecological approach due to the pressure of dwindling gas tax revenues. Thanks to economics, ecology was seen as a solution. Until this time, the 1950s agricultural management practice of mowing and spraying to make our roadsides look like our front yards, was the prevailing approach. Operation Wildflower was encouraged by the Federal Highway Administration (FHA) beginning in 1973.

3. 1980s - We saw the continued exploration of the ecological approach with more pressure by wildlife habitat supporters. 1985 saw the passage of the Rural Mowing Act in Minnesota. By limiting mowing of rights-of-way to the month of September, it was believed that birds and small mammals could nest and raise young successfully. On a national scale, the 1987 Wildflower Policy Act administered by the FHA influenced all states

seriously. They were now obligated to spend ¼ of 1% of their landscape budgets on establishment of native wildflowers in any construction project that used federal funds. States still continue to interpret the act differently. In the midwest, DOTs are consistently specifying native forbs and grasses as native wildflowers.

4. 1990 - 1990 brought the official beginning of the Minnesota DOT Wildflower Program. This program was the result of the described history and the Lieutenant Governor's Wildflower Task Force. This task force reported to the Governor in 1988 that preservation and restoration of Minnesota's natural heritage should be incorporated into roadside policy—it was. Since then, the Minnesota DOT has experimented with different restoration techniques like interplanting and preservation efforts including designated Wildflower Routes.

Restoring my childhood memory is more than an ecological solution, or roadside policy for the midwest. It is a solution for the future repair of plant communities throughout the world. Putting back the plants that carpeted the landscape before human disturbance is relevant to reforestation, biological diversity, sustainable agriculture, and many current environmental issues which are much larger than the small goat prairie that began this history. However, that vestige of the past, like others, has much to teach us about future restoration potential in the midwest.

TALL GRASS PRAIRIE RESTORATION PROJECT: PRELIMINARY FINDINGS

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ABSTRACT

The Tall Grass Prairie Restoration Project (TGPRP) was initiated in 1990 by Prairie Habitats, with funding from Wildlife Habitat Canada (WHC) and Hoechst Canada Inc., to determine the optimum methods of restoring tall grass prairie in Manitoba. Seeds from 113 plant species were harvested from relic tall grass prairies in southern Manitoba. Three 1 ha sites, at separate locations near Winnipeg, were prepared for seeding by cultivation and harrowing or rototilling and roller packing. Experimental design compared spring versus fall seeding dates and drilling versus broadcasting seed with mulching, irrigation, supplemental seeding, fertilization, and soil impoverishment sub-treatments. Preliminary results suggests that drilling prairie grass seed results in higher germination rates than broadcasting. Conversely, prairie forbs germinate at higher rates when broadcast. Weedy grasses and overall weed cover are reduced by cultivation prior to spring seeding.

INTRODUCTION

The TGPRP was initiated in the spring of 1990 by Prairie Habitats with funding from WHC and Hoechst Canada Inc. The goal of this five-year project is to determine the optimum methods of restoring tall grass prairie in Manitoba, on lands where this vegetation community no longer exists. The study arose out of recommendations in World Wildlife Fund Canada's Prairie Conservation Action Plan (1988).

STUDY SITES

Three sites in the Winnipeg region were chosen as experimental sites. The first is 4 km south of Ste. Agathe, Manitoba, in the median between two lanes of Provincial Highway #75. The second is in Beaudry Provincial Heritage Park, 10 km west of Winnipeg. The third is in northeast Winnipeg in Kil-Cona Regional Park. The first two sites are reclaimed agricultural fields with chernozem soils. The third is a landfill redevelopment with clay soils.

METHODS

Seed Harvesting

Seed was harvested from relic tall grass prairies in southern Manitoba in 1990. Hand harvesting accounted for small quantities of seed from a wide array of species. Mechanized harvesting, with custom built seed strippers, provided larger quantities of seed from the more common species. More than 200 kg of Big Bluestem (*Andropogon gerardii*) and about 50 kg from a total of 112 other species were harvested. Seeds were processed and cleaned in a variety of manners prior to being sown. Twenty-nine species were used in the basic restoration mixture: 6 grasses and 23 forbs (Appendix 1).

Experimental Design

The two primary variables being compared in this research are seeding date (spring versus fall) and manner of seeding (drilling versus broadcasting). On all three sites, 1 ha plots were laid out on a grid pattern with half of each site to be seeded in the fall and half in the spring. Respective halves of fall and spring seeded plots were seeded by drilling and broadcasting. Each of the resultant ¼ ha plots was divided into 20 equal sub-plots (125 m^2) to allow for additional subtreatments to be applied. Sub-treatments were applied on 3 sub-plots within each of the 4 major plots. Subtreatments included straw mulching, irrigation, supplemental seeding (applied in 1990), fertilization, and soil impoverishment (applied in 1991). For brevity sake these sub-treatments will not be discussed further in this paper. A number were discontinued in 1991 and no effects attributable to any of the sub-treatments were apparent.

Site Preparation

Site preparation consisted of cultivation, either by deep-tilling and harrowing (fall 1990) or by rototilling and roller-packing (spring 1991). Plots were harrowed or packed until a firm seed-bed was attained.

Seeding Techniques

A Truax native seed drill was used to drill seed. A known weight of seed, equivalent to 25.2 kg/ha, was added to the seed box. Several passes were made over the entire plot to ensure even coverage and a complete as possible delivery of all seed in the box.

Broadcasting was accomplished by band from the back of a half-ton truck. The required seed was split into two equal lots. Plots were then covered twice to ensure even coverage. A chain dragged behind helped incorporate and pack the seed. Spring seeded plots were roller packed after seeding. Broadcast seeding rate was twice that for drilling, 50.4 kg/ha.

Fall plots were sown at Beaudry and Ste. Agatbe the week of October 20, 1990, spring plots in the week of June 20, 1991. Fall plots at Kil-Cona were sown on October 15, 1991. The spring plot is to be sown in June 1992.

Weed Control

Weed control at Ste. Agathe and Beaudry involved mowing with a tractor mounted, 3-point-hitch, 1.2 m wide rotary mower set at 15 cm above the ground. The sites were mowed twice in 1991, in mid-July and in mid-August. Clippings were left on the plots.

Baseline Environmental Measurements

Snow cover was measured on all three sites in February and March 1991. Monthly temperature and precipitation data were obtained from the Atmospheric Environment Service for the three stations closest to the experimental sites. Soil samples were collected on each site, and subjected to standard soil analysis.

Plot Monitoring

Monitoring of the fall seeded plots began in May 1991. Sampling was done bi-weekly, or as weather conditions permitted, until early September. Spring seeded plots were first sampled on July 8, 1991.

Sampling to estimate plant densities was conducted as follows. A quarter metre square quadrat was placed randomly on each sub-treatment and control sub-plots. All the seedlings of each species were identified and counted. Large numbers of weed seedlings necessitated the use of 1/16 m^2 quadrants for weed counts. Within each ¼ ha plot the number of samples ranged from 6-12 on each sampling date. All data were converted to numbers of plants/m^2.

RESULTS AND DISCUSSION

Baseline Environmental Conditions

Snow cover on all three sites in 1991 was minimal: Ste. Agathe (5 cm); Beaudry (20 cm); and Kil-Cona (12 cm). The period November 1, 1990 through October 31, 1991 had below average precipitation for all three stations. Rainfall in spring and early summer, 1991 was thought to be adequate to promote germination.

There are substantial differences in soil conditions among the three sites. Nitrogen levels were highest at Ste. Agathe, followed by Beaudry then Kil-Cona. Phosphorus was highest at Ste. Agathe, followed by Kil-Cona and Beaudry. No effects attributable to soil nutrient differences between sites are apparent at this time.

Plant Densities

The preliminary nature of these findings warrants only a cursory discussion at this time. For brevity sake, only results from the Beaudry site are presented here. Densities of prairie plants were much lower at Ste. Agathe and there were few apparent trends in the data. At Beaudry mean densities of prairie grass seedlings, mainly Big Bluestem, ranged from 19.6 to 62.4/m^2 (Figure 1). There were no apparent differences between the mean densities of prairie grasses on drilled versus broadcast plots for both fall and spring seeding. This is despite the fact that grass seed was broadcast at twice the rate it was drilled, 44.4 kg/ha broadcast versus 22.2 kg/ha drilled. This suggests that drilling grass seed results in a higher germination rate.

Fall seeded prairie grasses were initially found in higher numbers than were spring seeded grasses. However, relative numbers were approximately the same on both plots by the end of summer. Whether this apparent decline in success of the fall seeded plots

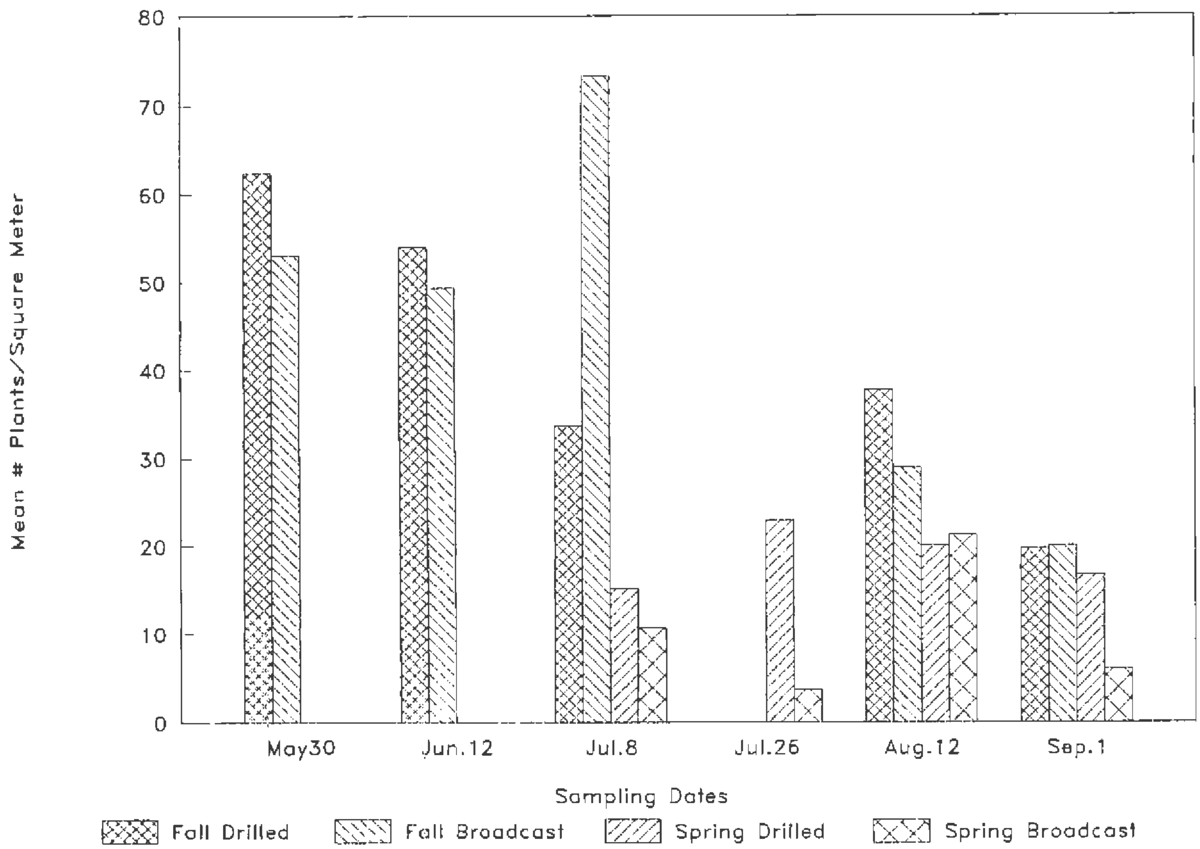

Figure 1. Mean densities of prairie grass seedlings at Beaudry, 1991.

is real or merely sampling error, owing to increased weed cover, remains to be seen.

Mean densities of prairie forb seedlings ranged from 2.6 to 15.7/m^2 (Figure 2). Unlike the grasses, forbs exhibited substantial differences in mean densities attributable to the manner of seeding. In all but one instance, mean densities in broadcast plots exceeded that of the respective drill plots, averaging 3.6 times higher. This is despite seeding rates only twice that for drilling. Broadcasting appears to promote greater germination in forbs.

DISCUSSION

The first season of data gathering on this project has provided some insight into the practical aspects of prairie restoration. These findings are not yet substantiated. Data collection in future years may serve to confirm these preliminary results.

The observed densities of prairie grasses and forbs at the Beaudry site offer tantalizing evidence to support the common knowledge apparent in the literature. Most authors agree that when sowing native grasses the seeding rate for broadcasting should be twice that used for drilling (Rock 1981, Schramm 1978). However, documentation of trials to establish this recommendation are lacking. There is less agreement with regard to forb seeding rates, but the common knowledge now favours broadcasting forb seeds rather than drilling them (Bowen, pers. comm.). Reasons offered as to why the different manners of seeding favour grasses or forbs are numerous and largely untested. The current research may ultimately offer some of the first hard evidence to support the existing body of common knowledge.

Little can be said as yet regarding the relative effects of fall versus spring seeding. Prairie plant densities on fall and spring seeded plots were similar by the end of summer. One effect related to seeding date emerged from the weed populations. Cultivation of the soil

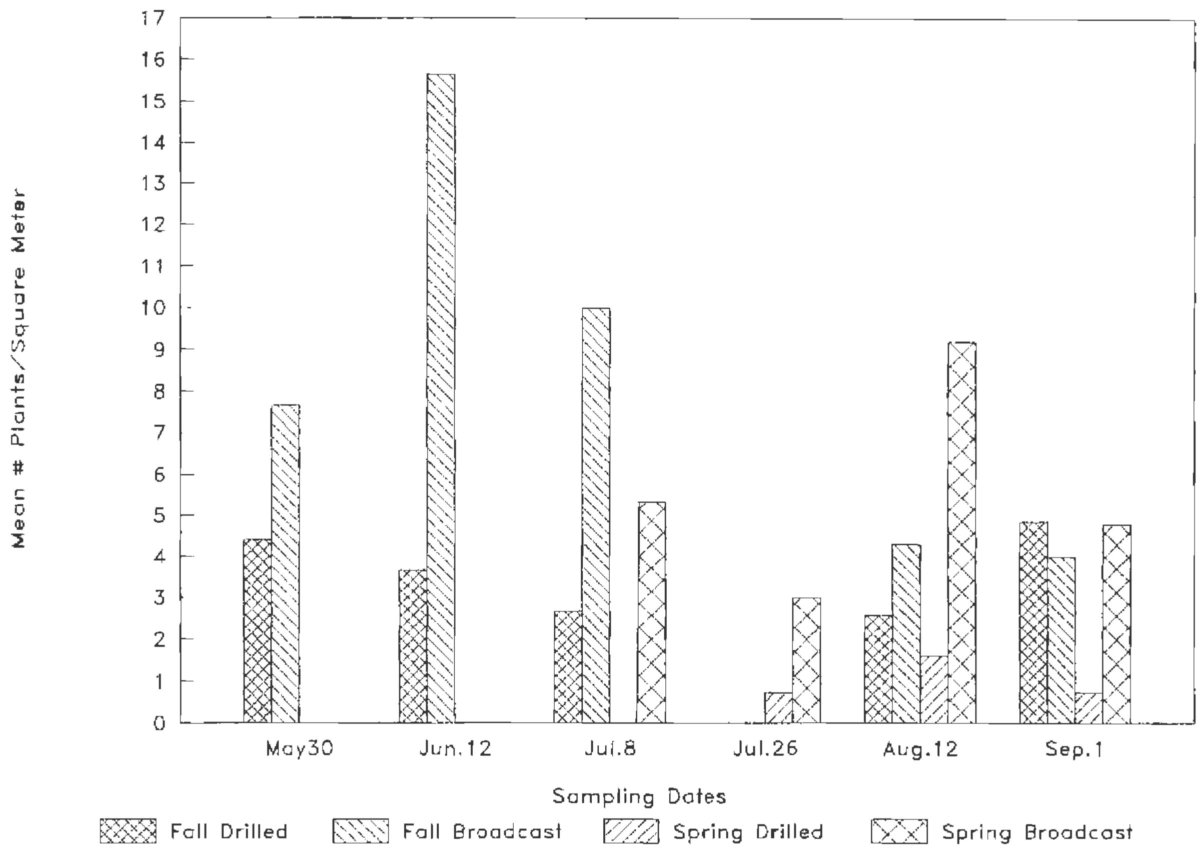

Figure 2. Mean densities of prairie forb seedlings at Beaudry, 1991.

prior to spring seeding resulted in a large reduction in weedy grass densities, particularly Wild Oats (*Avena fatua*), and an overall reduction in weed cover. Better weed control is one reason often stated for promoting spring seeding (Leskiw 1978, Schwarzmeier 1972, Betz 1986).

The TGPRP will continue until at least 1994. Future data collection and analysis, and further experimentation will hopefully lead to an improved body of knowledge on the practice of prairie restoration.

ACKNOWLEDGMENTS

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LITERATURE CITED

Betz, R.F. 1986. One decade of research in prairie restoration at the Fermi National Accelerator Laboratory (Fermilab). Pp. 179-184 *In:* The Prairie: Past, Present and Future - Proceedings of the Ninth North American Prairie Conference. Tri-College University Center for Environmental Studies, North Dakota State University, Pub. Fargo, North Dakota.

Leskiw, C.M. 1978. Guidelines for preservation, propagation and utilization of native grass prairies in Manitoba. M.Sc. Thesis. Natural Resource Institute. University of Manitoba, Winnipeg, Manitoba.

Rock, H.W. 1981. Prairie Propagation Handbook. Wehr Nature Centre, Milwaukee County Dept. of Parks, Recreation and Culture, Franklin, Wisconsin. 74 p.

Schramm, P. 1978. The "do's and don'ts" of prairie restoration. Pp. 139-150 *In:* Fifth Midwest Prairie Conference Proceedings (D.C. Glenn-Lewin and R.Q. Landers Jr., eds.). Iowa State University, Ames, Iowa.

Schwarzmeier, J. 1972. Competitional aspects of prairie restoration in the early stages. *In*: Proceedings of the Second Midwest Prairie Conference (J.H. Zimmerman, ed.). University of Wisconsin., Madison, Wisconsin.

World Wildlife Fund Canada. 1988. Prairie Conservation Action Plan. WWF, Toronto.

Appendix 1. Restoration seed mixture.

Plant Species	Weight of bulk seed (g) sown per 1/4 ha plot Drilled	Broadcast
Grasses		
Big Bluestem (*Andropogon gerardii*)	4,670	9,340
Indian Grass (*Sorghastrum nutans*)	280	560
Prairie Dropseed (*Sporobolus heterolepis*)	180	360
Switch Grass (*Panicum virgatum*)	90	180
Canada Wild Rye (*Elymus canadensis*)	150	300
Spear Grass (*Stipa comata*)	170	340
Subtotal	**5,540**	**11,080**
Forbs		
Purple Prairie Clover (*Petalostemon purpureum*)	235	470
Stiff Goldenrod (*Solidago rigida*)	43	85
Heart-leaved Alexander (*Zizea aptera*)	35	70
Narrow-leaved Sunflower (*Helianthus maximilianii*)	35	70
Leadplant (*Amorpha canescens*)	100	200
Three Flowered Avens (*Geum triflorum*)	25	50
White Prairie Clover (*Petalostemon candidum*)	65	130
Yellow Coneflower (*Ratibida columnifera*)	18	35
Gaillardia (*Gaillardia aristata*)	23	45
Beautiful Sunflower (*Helianthus subrhomboideus*)	20	40
Meadow Blazingstar (*Liatris ligulistylis*)	50	100
White Cinquefoil (*Potentilla arguta*)	15	30
Smooth Aster (*Aster laevis*)	15	30
Prairie Crocus (*Anemone patens*)	15	30
Rough False Sunflower (*Heliopsis helianthoides*)	10	20
Many Flowered Aster (*Aster ericoides*)	10	20
Graceful Goldenrod (*Solidago canadensis*)	10	20
Black Eyed Susan (*Rudbeckia hirta*)	5	10
Pink Flowered Onion (*Allium stellatum*)	5	10
Northern Bedstraw (*Galium boreale*)	5	10
Bergamot (*Monarda fistulosa*)	5	10
Yarrow (*Achillea millefolium*)	5	10
Alumroot (*Heuchera richardsonii*)	2	5
Subtotal	**750**	**1,500**
Total	**6,290**	**12,580**

* Seeding Rates = 25.2 kg/ha for drilled plots (22.2 kg/ha grasses plus 3 kg/ha forbs)
= 50.4 kg/ha for broadcast plots (44.4 kg/ha grasses plus 6 kg/ha forbs)

PLANT PHENOLOGY: BIOINDICATOR FOR CLIMATE CHANGE

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WHAT IS PHENOLOGY?

Phenology, defined as "the study of the seasonal timing of life cycle events" (Ratchke and Lacey 1985), has a long history. Information collected thousands of years ago in the Orient on the timing of events such as flowering of cherry trees, was used to make agricultural calendars. Carolus Linnaeus, who gave science the naming system we use for all living things, was the father of modern phenology.

In the plant kingdom, phenology generally studies the timing of development of flowers and leaves. "Phenophases" are growth phases which are easily observed, distinct milestones in a species' life cycle. Examples include: bud break, first leaf, first flowering, and ripe fruit. In animals, examples include the timing of arrival, nesting and migration of birds, and hibernation or emergence of mammals.

Plants can be considered as environmental measuring sticks, because they integrate the effects of weather. The advantage of using plants as weather instruments is that they are widespread, and less costly than man-made meteorological instruments.

Temperature appears to be the most important factor affecting the phenology of spring plant development in the temperate zone of the world. The timing of plant development in the first half of the year depends primarily on the amount of accumulated heat (Larcher 1983), which is often expressed in degree-days above a certain threshold such as 5°C. In particular, flowering of most temperate woody species and some perennial herbs is in response to accumulated temperature (Ratchke and Lacey 1985). Plants which flower in response to day length include mainly annual plants and grasses (Beddows 1968).

Caprio (1971) has shown that combining heat sums (degree-days) with solar radiation may give an even more accurate picture of the abiotic factors influencing lilac phenology. Common Purple Lilacs (*Syringa vulgaris*) grown in different areas—Montana, the west coast of the United States, and Norway—all required the same number of solar heat-units to flower.

HOW CAN PHENOLOGY HELP OUR UNDERSTANDING OF PRAIRIE ECOSYSTEMS?

In temperate areas of the world where we see pronounced seasonal changes, the sequence of development of organisms over the course of a year follows a predictable pattern. Once the sequence and average timing is known (after 10 years or more of data collection), this predictability can be used to provide indicators across trophic levels. For example, the appearance of first flowers on wild Saskatoon (*Amelanchier alnifolia*) or on Common Lilac may signal that in five days apple trees will bloom, or in 10 days an insect pest will appear. This data can benefit agriculture, as indicators have been developed for many insects including the European Corn Borer (*Ostrinia nubilalis*) (Hopp 1978), the Elm Bark Beetle (*Scolytus maltistriatus*), grasshoppers, and the Alfalfa Weevil (*Hypera postica*). Besides crop and pest management in agriculture, phenology has many other applications including forestry, remote sensing, human health, tourism, and even forensic law (Beaubien 1991a).

Phenological data allows us to monitor changes in climate through changing phenological patterns; since spring-flowering plants react to heat accumulation times, earlier and earlier flowering would be observed if the predicted global warming produces warmer winter and spring seasons. Phenology also allows us to track the effects of weather extremes on plant development. But it is important that we start collecting this baseline phenology data now!

WHAT PHENOLOGICAL DATA EXISTS FROM THE PAST?

In Europe, international networks of phenological observers date back two centuries (Hopp 1974). Presently many European countries have networks of volunteers coordinated by their national meteorological departments. The data collected is largely used to assist agriculture in various ways including crop protection, and land zonation. Volunteers among the general public as well as school classes record phenophases for both native and cultivated plants. This information has permitted fine-scale mapping of Switzerland and

Germany, which show how areas differ in their potential for agriculture and horticulture.

In 1959, an International Phenological Garden program was established in Europe, using clones of woody plants to eliminate phenological variation due to genetic influences. By 1987, 62 gardens were reporting data on these cloned species, on native plants and on weather. Lauscher and Roller (1980) examined the previous 17 years of data from 18 gardens in Norway and Austria for evidence of changes in timing. They found a slight lengthening of the growing season, with spring leafing occurring on average 0.36 days earlier, flowering 0.33 days earlier, and autumn phenophases 0.20 days later.

In the United States, regional phenology projects coordinated through the United States Department of Agriculture were launched in the 1950s. Networks of volunteers recorded phenology of flowering and leafing for cultivated species: Common Lilac and two honeysuckle (*Lonicera* spp.) cultivars. Dr. Joseph Caprio, based in Montana, began his survey in 1956 and by 1972 had 2500 observers across the western states (Hopp 1974). Presently he has about 500 observers, and he has observed earlier than average flowering of Common Lilac through much of the 1980s (Caprio pers. comm. 1990). Funding for the survey in the eastern United States has recently come to an end, though about 50 observers still submit data and 30 years of phenology data is available from the present coordinator, Mark Schwartz (pers. comm. 1992).

To my knowledge, these long-term data still await analysis for correlation with climate change. The existing databases will provide an invaluable baseline against which to compare future trends in global warming. Long-term monitoring should be a major priority for environmental research, so that change will be evident to us in future! As Likens (1983, page 241) noted: "Many, if not most of the current environmental problems, (e.g., acid rain, toxic wastes, etc.) would not be controversial issues if there had been long-term data from which trends and effects could be determined."

Canadian interest in phenology began in 1890 with a national phenology project started by the Royal Society of Canada and carried out until at least the 1920s by the Botanical Club of Canada. These records were published annually in the Transactions of the Royal Society of Canada. Since then Canada's only major extensive survey has been the involvement of volunteers in the eastern provinces in the eastern United States regional phenology project. One interesting intensive phenology study carried out close to the site of this conference, Brandon, was by Norman Criddle (1927) who published the average first flowering dates and time required to set seed for 400 native species.

Extensive phenology studies using a volunteer network of observers began in Alberta in 1973 (Bird 1974) with a 10-year study carried out by Dr. Charles Bird through the Federation of Alberta Naturalists. Starting with flowering observations of 100 native wildflowers, Dr. Bird whittled the list down to 12 "key" phenology species. All are native perennials, easy to recognize, widespread, and with a relatively short and consistent flowering period.

Usiug these 12 species and adding three more to increase representation from northern Alberta, I launched a new Alberta survey in 1986, and subsequently have received data from about 200 observers annually. The 15 species in flowering sequence are: Prairie Crocus (*Anemone patens*), Aspen Poplar (*Populus tremuloides*), Early Blue Violet (*Viola adunca*), Golden Bean (*Thermopsis rhombifolia*), Saskatoon, Star-flowered Solomon's-seal (*Smilacina stellata*), Choke Cherry (*Prunus virginiana*), Wolf Willow, (*Elaeagnus commutata*), Yellow Pea Vine (*Lathyrus ochroleucus*), Northern Bedstraw (*Galium boreale*), Twin-flower (*Linnaea borealis*), Common Yarrow (*Achillea millefolium*), Western Wood Lily (*Lilium philadelphicum*), Brown-eyed Susan (*Gaillardia aristata*), and Fireweed (*Epilobium angustifolium*). Observers are sent "Alberta Wildflowers," a 24-page publication which illustrates the plants and explains when and how to observe. They return their data sheets at the end of the growing season with the dates when first flowering, mid- or 50% flowering, and full flowering occurred for the species they observed.

For my Masters research (Beaubien 1991a), I tried a number of mapping techniques to illustrate the flowering progression of each species across Alberta. The most successful technique was using the Geographic Information Systems program SPANS (Spatial Analysis System) (TYDAC Technologies 1989).

Mapping showed a general trend in flowering starting in a southeast-northwest corridor, with flowering occurring first in southeastern Alberta, and later heading northeast, north, and southwest into the mountains.

The earlier flowering influence of the city "heat islands" was evident. Once a denser network of observations is available, and many years of data are averaged, the resulting maps will provide valuable ecoclimatic data to show how areas of Alberta differ in growth potential.

With global warming, plant populations will be affected. Changes in plant distribution will likely be most observable at the north and south boundaries of their distributions. The phenology network will be of great value to observe and record plant population dynamics, for the 15 key phenology species and any others requested. Ideally information should be gathered on a whole phenosequence of wildlife development for different regions, integrating the phenology of plants with that of microorganisms, insects, birds, mammals, etc. One of the key recommendations of the United States Regional Climate Centres on the subject of climate change, is to strengthen their deteriorating climate observing network, to allow them to quantitatively measure changes in climate. The Alberta phenology network can assist the Canadian Atmospheric Environment Service in additional climatic coverage of the province.

HOW CAN PHENOLOGY HELP PROMOTE A SUSTAINABLE PRAIRIE ENVIRONMENT?

This survey offers an excellent educational opportunity for the public, young and old, to learn first hand about the relationships between plants (and insects, etc.) and climate (Beaubien 1991b). This increased interest and awareness provides incentives to care about native habitats and can only lead to wise stewardship of our remaining prairie environments. In the southern Canadian prairies, 70% of the average cattle farm is still native grassland (Trottier 1992), so there is much habitat left well-suited to this phenology study and that needs to be preserved. Participation by farmers and ranchers in this study will improve communication between them and the conservation and research community.

Funding is currently being sought to promote and expand this program in Alberta. It would also be very valuable for the prairies and Canada to then extend the survey nationally, and to link up with databases in the United States.

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LITERATURE CITED

Beddows, A.R. 1968. Head emergence in forage grasses in relation to February-May temperatures and the predicting of early or late springs. Journal of the British Grasslands Society 23:88-97.

Beaubien, E.G. 1991a. Phenology of vascular plant flowering in Edmonton and across Alberta. MSc thesis, Department of Botany, University of Alberta, Edmonton.

Beaubien, E.G. 1991b. Phenology: the potential for education. p.117-121 *In:* Proceedings of the Second Endangered Species and Prairie Conservation Workshop (G.L. Holroyd, G. Burns, H.C. Smith eds.). Natural History Occasional Paper 15. Provincial Museum of Alberta, Edmonton, Alberta.

Bird, C.D. 1974. 1973 flowering dates. Alberta Naturalist 4(1):7-14.

Caprio, J.M. 1971. The solar-thermal unit theory in relation to plant development and potential evapotranspiration. Montana Agricultural Experiment Station Circular 251:1-9.

Criddle, N. 1927. A calendar of flowers. Canadian Field-Naturalist 41:48-55.

Hopp, R.J. 1974. Plant phenology observation networks. Pp. 25-43 *In:* Phenology and seasonality modelling. Ecological studies: analysis and synthesis, Vol. 8 (H. Lieth ed.). Springer-Verlag, N.Y.

Hopp, R.J. 1978. editor. Phenology: an aid to agricultural technology. Vermont Agricultural Experiment Station Bulletin 684. 51 pp.

Larcher, W. 1983. Physiological plant ecology, 2nd edition. Springer-Verlag, Berlin.

Lauscher, F. and M. Roller. 1980. Comparisons of observations in phenological gardens and phenological networks. International Journal of Biometeorology. Supplement to Vol. 24: 85-86.

Likens, G.E. 1983. Address of the past president: a priority for Ecological Research. Bulletin Ecological Society of America 64: 234-243

Ratchke, B. and E.P. Lacey. 1985. Phenological patterns of terrestrial plants. Annual Review of Ecological Systematics 16:179-214.

Trottier, G. 1992. Conservation of Canadian prairie grasslands: a landowner's guide. Canadian Wildlife Service, Environment Canada

TYDAC Technologies. 1989. Spatial Analysis System (SPANS), Version 4.3. Reference Guide. Ottawa, Ont.

PRAIRIE ECOSYSTEM SUSTAINABILITY AND CLIMATIC VARIATIONS

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ABSTRACT

The nature of the relationships between climate and the prairie agroecosystem is explored by means of a review of prairie climate impact assessments. The assessments have examined the impacts of both past climates and possible future climates. Although the potential effects of global warming on prairie ecosystems have not yet been significantly researched, some examples are provided. Also, the impacts of past climates provide an indication of sensitivities of systems to climate and of the need for improved adaptation. Examples of numerous and often serious effects of climatic variations are provided by Wheaton and Arthur (1989), for example, who examined the environmental and economic impacts of the 1988 drought. Possible climatic change impacts have been assessed for a few sectors in the Canadian prairie provinces, including agriculture (e.g., Williams et al. 1988, Arthur 1988), water resources (e.g., Cohen 1991), forests (e.g., Wheaton et al. 1987), and wetlands (e.g., Woo 1991). Issues addressed include land degradation, biomass productivity, and climatic zonation. Questions regarding the nature of prairie sustainability through future climatic variations are raised. The threat of human induced climatic change increases the need to increase the knowledge of these linkages and to promote a more sustainable prairie environment. A project regarding adaptive strategies for reducing the uncertainties associated with a variable and changing climate in the Canadian prairie provinces is outlined. Adaptation, in this context, means the harmonization of human activities and ecosystems with a variable and changing climate for sustainable development. Adaptation to climatic change requires proactive planning, anticipating the future, providing ourselves with as many options as possible, both today and in the future. Learning to better adapt today to a variable climate puts us in a better position to respond tomorrow to significant changes in the present patterns of climate. Adaptive strategies will better enable us to maximize opportunities and positive impacts, and to minimize constraints and negative impacts (Parry et al. 1988).

LITERATURE CITED

Arthur, L.M. 1988. The Implications of Climate Change for Agriculture in the Prairie Provinces. Climate Change Digest CCD 88-01. Environment Canada, Atmospheric Environment Service, Downsview, Ontario.

Cohen, S.J. 1991. Possible Impacts of Climatic Warming Scenarios on Water Resources in the Saskatchewan River Sub-Basin, Canada. Climatic Change 19: 291-317.

Parry, M.L., T.R. Carter, and N.T. Konijn (eds.) 1988. The Impact of Climatic Variations on Agriculture, Vol. 1: Assessments in Cool Temperate and Cold Regions. Kluwer Academic Publisher, Dordrecht, The Netherlands.

Wheaton, E.E., T. Singh, R. Dempster, K.O. Higginbotham, J.P. Thorpe, G.C. van Kooten, and J.S. Taylor. 1987. An Exploration and Assessment of the Implications of Climatic Change for the Boreal Forest and Forestry Economics of the Prairie Provinces and Northwest Territories. Saskatchewan Research Council, Saskatoon, Saskatchewan.

Wheaton, E.E. and L.M. Arthur (eds.) 1989. Environmental and Economic Impacts of the 1988 Drought: with Emphasis on Saskatchewan and Manitoba. Prepared for the 1988 Drought Committee. Saskatchewan Research Council, Saskatoon, Saskatchewan.

Williams, G.D.V., R.A. Fautley, K.H. Jones, R.B. Stewart, and E.E. Wheaton. 1988. Estimating Effects of Climatic Change on Agriculture in Saskatchewan, Canada. Pp. 219-379 *In*: The Impact of Climatic Variations on Agriculture, Vol. 1: Assessments in Cool Temperate and Cold Regions (Parry, M.L., T.R. Carter, and N.T. Konijn eds.). Kluwer Academic Publisher, Dordrecht, The Netherlands.

Woo, M-k. 1991. Impacts of Climate Variability and Change on Canadian Wetlands. Canadian Water Resources Journal 17(1): 63-69.

INSECTS AND CLIMATE CHANGE: PROSPECTS FOR POPULATION CHANGES AND IMPLICATIONS FOR ENVIRONMENTAL QUALITY

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INTRODUCTION

Ecosystems and agricultural systems share a reliance on climate to provide the energy and conditions that are necessary for productivity and survival. There has been considerable speculation regarding the fate of these systems under various scenarios of global climate change. This is a matter of special concern in high-latitude continental regions such as the Canadian prairies, in which changes in climate might be predicted to cause important changes in the resilience and geography of wetlands, rangelands, forests, and cropland.

The regional effects of global climate change on prairie biomes will not be limited to vegetation and vertebrates. Insects are also strongly influenced by weather and vegetation, and are prominent features of ecological systems, accounting for a large part of the total diversity. Their abundance and timing also make them important food sources for vertebrate wildlife, and as pollinators they directly affect productivity and continuity in both native and crop systems. Their sequestering of a significant portion of the biomass, combined with recurring population explosions, give them significant roles in the trophic dynamics of ecosystems, and brand them as pests in many agricultural contexts. Consequently, insects may affect issues of prairie conservation directly, in their capacity as important ecological residents, and indirectly through the impact of some pesticides used for their control.

Climate and weather are especially important factors in the lives of insects native to prairie biomes. As climates change, both in long-term mean values of climate and short-term variability of weather, insects will respond according to their present adaptations to the physical environment. Short generation time and high rates of mobility allow prominent insect species to react quickly to climate change, and become more common in new environments that open up by shifts in the range and timing of temperature and moisture. This result makes possible the use of insect fauna as bioindicators: the first evidence of a lasting ecological reaction to climate change may appear among the insects. The close relationship of insects to weather and climate also portends new problems regarding the geography, intensity, and potential impact of future insect control measures. These questions and issues have resulted in the recent initiation of research on the impact of climate change on insects.

THE NAT CHRISTIE FOUNDATION CLIMATE CHANGE RESEARCH PROJECT

A five-year project, starting in January of 1992 and involving a total of nine researchers at the University of Lethbridge and the Lethbridge Research Station, was designed to determine the probable impact of climate change on agriculture in Alberta. The principle component of the Nat Christie Foundation research project characterizes crop growth and its interaction with soils and pests, primarily insects. Models of dryland and irrigated crop production, with appropriate insect pest components, will be used to forecast possible problems and opportunities under various scenarios generated by the general circulation models of climate change. There are a numher of generalized crop models, typically driven by temperature and photoperiod, and controlling the partitioning of carbon. Plant biomass accumulation, both grain harvest and whole plant yield, is driven by solar radiation, moisture availability, and, to a lesser degree, temperature. Cultivar differences in crop models can be modelled by modifying the appropriate coefficients relating development and photosynthesis to environmental parameters. Ouce appropriate crop models have been developed, the insect factor will be added. The impact of insect pests on crops is primarily negative, but not always timed in the same way or of the same intensity. Two insect models and a crop/insect interaction model will be utilized. The main insect model will detail the dynamics of the pest populations, so that changes in species, age, distribution, and abundance may be simulated. A population model of this type consists of differential equations that model insect stages and resulting population growth, and includes newly developed and parameterized functions of survival, development, and reproduction as functions of time, temperature, and other relevant environmental variables. Within a given year of interest, this model will simulate the impact of weather and related variables on population age, density, and activity. The output of a long-term spatial version (i.e., couched in a geographic computer modelling system) of this model will describe the expansion and longevity of insect outbreaks, and the consequences for crop production in these areas. The approach will be applied to existing and severe insect pests, such as grasshoppers and cutworms, and to hypothetical insect pests that could become established under various scenarios of changing climate and cropping practice. The next step in the exercise will be to forge linkage between the insect pest submodels and the crop models, either via direct combination of subroutines, or through construction of a database of insect outbreak scenarios. An additional application of this process model will be to screen the economics and long-term effectiveness of scenarios of alternative control practices, designed to promote sustainable agriculture and identify opportunities for reducing insecticide usage. For example, is it possible to anticipate and recognize changes in insect distribution and abundance that have resulted from climate change? Can we identify areas in which to employ intensive scouting to prevent insect infestations from spreading? Can we identify climatic zones in which the activity of natural enemies, like fungi that occasionally cause diseases of insects, could be enhanced?

The second insect modelling approach planned is essentially statistical or empirical. This is not a competing method that will preclude a process modelling approach, but one that will provide reasonable estimates of expectations and provide a means of testing and refining the process models. A geographic information system database of grasshopper data will be used to characterize spatial and temporal autocorrelation, and to describe the insect population responses that have been observed following certain patterns of weather. The basic premise of the empirical approach is that the insect populations will respond to climatic variability and change in a way that is similar to their responses in the past. One additional output of this second approach would be a concise historical description of the meteorological conditions that have influenced grasshopper outbreaks in this century. Such a quantitative description would have the additional benefit of testing and improving insect forecasting methodology.

BACKGROUND ON GRASSHOPPERS

An example of how climate change might alter the pattern of insect outbreaks can be seen in the case of recurring grasshopper infestations. Although the outbreak of the mid-1980s has since declined to more moderate levels, grasshoppers remain the most destructive pests of cereal crops and range grass in many parts of the Great Plains and Prairies of the United States and Canada. The most severe economic losses are caused by the four major grasshopper species known to attack crops: *Melanoplus bivittatus*, *M. packardii*, *M. sanguinipes*, and *Camnula pellucida.* Grasshoppers are not new or introduced pests (in fact their depredations in the 19^{th} century were worse). Their adaptations to weedy succession areas equipped them to become a periodic feature of cropland.

The potential for crop loss is significant in most years, but damage from these pests can be particularly extensive during peak outbreak years. The present outbreak is a typical one in which grasshoppers rapidly increased in abundance in crop and grassland regions, and then slowly declined. There have been roughly seven outbreak peaks of several years each since monitoring began in the 1920s. In high-density areas, grasshoppers remove forage that would otherwise feed livestock, and threaten cereal and oilseed crops throughout the season. They can kill newly emerged seedlings, and their chewing in mid-season reduces subsequent yields. Just before harvest they may feed directly on the ripening grain. In some years, soil erosion resulting from the destruction of cover crops by grasshoppers has been reported.

For now, the only available response to significant grasshopper infestations, other than doing nothing and suffering crop loss, is wide-scale spraying of insecticides. For example, provincial sales records indicate that in Alberta in 1985, a total of 410,000 litres of insecticide (from 6,600 purchases) were applied to 780,000 ha of agricultural land. One of the research challenges in the management of this pest is to substantially reduce the amount of chemical insecticide required to ameliorate these infestations, in part through anticipation of the changing pattern of application that may occur under future climates and cropping practices. For example, a northward increase in the growing season accompanied with higher temperatures and periods of reduced moisture might indicate that greater use of insecticide would occur in these areas. Advance warning would reduce the negative impacts on sensitive areas. Advance notice of where outbreaks will occur may even aid in the development of natural control methods, for example, application of weather-dependent pathogens that cause grasshopper diseases, or targeting regions in which natural controls can be encouraged.

It is well-known that several consecutive years of warm, dry weather have preceded the major grasshopper outbreaks, but in many cases the details of the relationship are unknown. To predict the future distribution and abundance of insects, it is necessary to identify the climate variables that significantly affect their survival, growth, and development. Some of these studies have been completed or are underway in a number of locations. The next steps are to construct reasonable models of the reaction of the insects to weather and climate, and then to apply climate forecasts to the insect models in order to generate a predicted map of future pest activity, as discussed above. These insect-crop-climate models are expected to reveal significant changes in crop protection scenarios, because the dominant insect pests are strongly influenced by the quantity and timing of heat and moisture. For example, predictions based on the Goddard Institute for Space Studies general circulation model indicate a longer growing season and an increase in the occurrence of drought (Stewart 1990). These changes, coupled with a 4^{0}C increase in average temperature, may be expected to result in more frequent outbreaks of grasshoppers, and a possible northward shift in infestations of cutworms and aphids, but precise estimates will require more explicit comparison of insect ecological requirements and predicted climate change pattern (it can become too hot and dry even for grasshoppers). However, depending on the model used, a doubling in CO_2 can be expected to increase surface temperatures between 3^{0} and 7^{0}C, with increases of up to 30% in rainfall in some regions of Alberta.

Models of the impact of climate change on cropping practice are also required, because the economic loss due to insects such as grasshoppers, cutworms, and aphids is dependent on the crops and cropping practices selected.

CASE STUDY: GRASSHOPPER OUTBREAKS IN ECOREGIONS OF ALBERTA

When beginning a study of insects and the probable impact of climate change, it is instructive to first look for empirical evidence that would help develop or validate models of how the insects have reacted under various climate regimes or ecoregions. In order to reorganize the Alberta grasshopper database along climatic divisions, I divided and summarized 22 years of grasshopper survey data by ecoregion.

The various ecoregions and ecodistricts of Alberta are delineated on the basis of physical and biological variables that affect vegetation and wildlife native to each area. The classification of Alberta ecoregions was described by Strong and Legatt (1981) and has been recently updated (Strong 1991). Definitions are based on separation according to vegetation physiognomy, soil genetic composition, surface features, soil classification, soil texture, slope, and climate. Climatological classification is based on weather measurements, including expected values, ranges, and timing of temperature and precipitation. The Prairie Ecoprovince is divided into 4 ecoregions (in order of increasing moisture regime): Dry Mixed Grass, Mixed Grass, Fescue Grass, and Aspen Parkland, all of which are zones that have periodically hosted grasshopper population explosions. Grasshoppers are less common pests in the Boreal Ecoprovince and in the Cordilleran Ecoprovince, so these were not included in this study.

In theory, ecological zonation can be usefully applied to analysis and prediction of the activities of plant pests for two main reasons. First, the types of vegetation exposed to attack vary among ecological zones, and the availability of food or a host plant is a key factor determining pest distribution and population dynamics. Second, the pests themselves react ecologically to some of the same variables used to define ecological zones, as discussed above. This information, once formalized and validated, could be used to forecast changes in endemic pests as weather changes, or to predict the likely spread and subsequent distribution of introduced pests (such as is the aim of the Australian climate-matching program CLIMEX; Sutherst 1991). Forecasts of damage from pests of economically important vegetation are typically based on analysis of the ecological requirements for their survival and growth, and determination of the conditions which will allow individuals to prosper and populations to expand. Some of these ecological requirements are easily measurable, often abiotic, factors that have been used to define ecoregions, and therefore, standard ecoregion classifications and analytical methods may add predictive and explanatory power to pest risk assessment models. If pests react ecologically to some of the same variables used to define the zones, this information can be used to predict the likelihood of pest establishment and growth, both for new or introduced pests and for established pests that have been perturbed by environmental change.

Although the most powerful application of the principles of ecological zonation to prediction of the activities of crop damage will be through the use of process models of the ecological requirements of the pest, analysis of historical data can provide useful evidence of differences in pest performance among ecological zones. In the example below, the dynamics of two decades of grasshopper infestations in four ecoregions of Alberta are shown.

The comparison was possible because of the existence of the grasshopper survey database. Timing is important in grasshopper control, and advance warning of changes in the geographical pattern and severity of outbreaks is required to plan control measures. To meet this need, annual surveys of grasshopper abundance in Alberta are conducted. The method of sampling and mapping was standardized in 1932, updated in 1970 (Smith and Holmes 1977) and combined with geographic information system technology in 1987 to produce annual Alberta grasshopper forecasts (Johnson 1989a). Agricultural field personnel conduct detailed surveys each year in early August when most grasshoppers are in the adult stage. Around the end of July at each of up to 2,000 randomly selected locations per year, trained surveyors (permanent staff of the Alberta Agriculture Service Board) record the vegetation type and grasshopper counts in 100 m transects along the roadside, and in similar 100 m walks through the adjacent field. A summary is used to produce maps forecasting the risk of crop damage for the coming year. Similar surveys are conducted in Saskatchewan and Manitoba.

ANALYTICAL METHODS

The grasshopper survey database, consisting of observations at over 21,000 sites, was subdivided according to the ecoregions defined by Strong (1991). The site records were ordered by latitude and longitude, and assigned an ecoregion value (using SPANS [Spatial Analysis System], SAS [Statistical Analysis System], and original computer software). Mixed model analysis of variance of the log-transformed grasshopper counts was applied to compare differences among years and ecoregions. Also included in the ANOVA (Analysis of Variance) model to predict grasshopper density were the counts from the nearest site from one, two, and three years before, for each site.

RESULTS AND DISCUSSION

When the grasshopper survey records are divided and plotted according to ecoregion, it is clear that the outbreaks differed in intensity and even in timing in the different biomes (Figure 1). The analysis of variance indicated that ecoregion was a highly significant

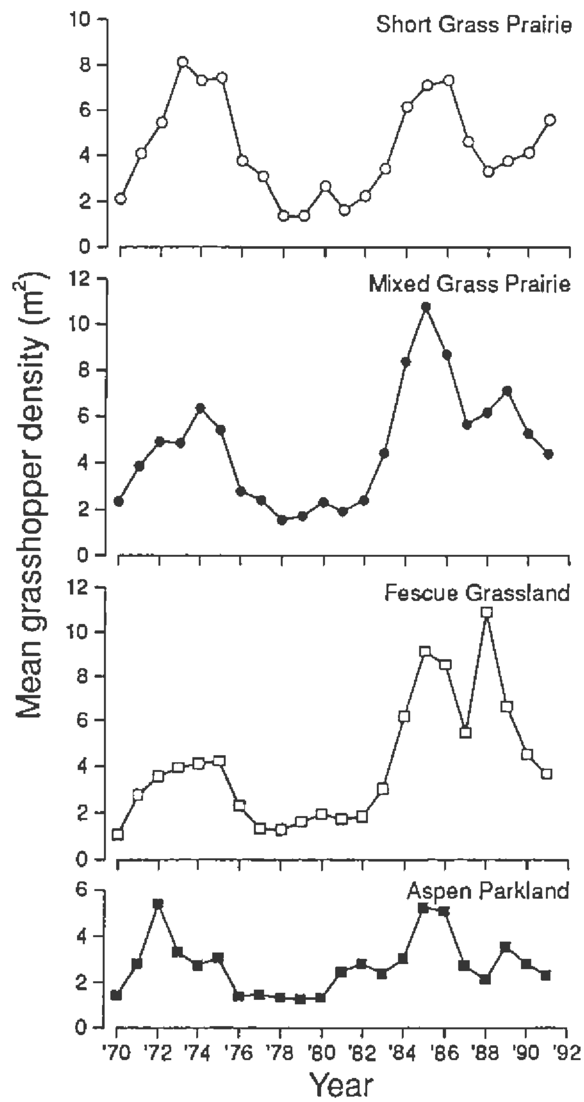

Figure 1. Average roadside grasshopper counts from the Alberta grasshopper survey database. Samples sizes (numbers of survey sites) of the four ecoregion plots are as follows: short grass prairie - 6,736; mixed grass prairie - 5,583; fescue prairie - 2,226; aspen parkland - 5,727.

factor accounting for differences in densities of grasshoppers over time, even after the effects of the previous three years population density were removed. This means that the abundance of grasshoppers depended not only on the previous population density, but was strongly effected by regional environmental variables (primarily the timing and availability of beat and moisture). Differences in timing and severity of the grasshopper outbreaks are clearly visible in summary plots (Figure 1), and the significance of the ecoregion factor persisted even when the Aspen Parkland ecoregion was removed from the analysis, and when the 1970s were analyzed separately.

Ecoregion differences are apparent even in the most recent years (Figure 1). For example, the recent declines in the outbreak did not occur as quickly or in the same pattern in all ecoregions (note the increase in Short Grass Prairie). The distribution may have changed over time. Although the outbreak of the mid-1970s was most severe in the Short Grass Prairie ecoregion, the average grasshopper population density in the mid-1980s was greater in the Mixed Grass Prairie ecoregion. Further analysis is in progress to determine whether this ecoregion shift was related to a shift in moisture and temperature, which could indicate that the climatic component of the definition of ecoregion definitions may have changed during this period. Are ecoregions already moving? In any case, the results indicate that the extent and even the timing of grasshopper cycles varies among ecoregions, and determination of the reasons may help to predict the response to climate change.

Mechanisms may be identified to explain the differences in insect outbreak dynamics among ecoregions, or it may be that the causes are more complex and changing. Overlay and statistical methods offer useful evidence and comparisons regarding the geographic dynamics of pests (e.g., soil type and texture, Johnson 1989b), but particular mechanisms must be hypothesized and tested with more direct methods. This is the challenge of the next step in research on insect outbreaks and climate change.

LITERATURE CITED

Johnson, D.L. 1989a. Spatial autocorrelation, spatial modelling, and improvements in grasshopper survey methodology. The Canadian Entomologist 121: 579-588.

Johnson, D.L. 1989b. Spatial analysis of the relationship of grasshopper outbreaks to soil classification. *In*: Estimation and Analysis of Insect Populations. Lecture Notes in Statistics, 55: 347-359. Springer-Verlag, New York.

Smith, D.S., and N.D. Holmes. 1977. The distribution and abundance of adult grasshoppers (Acrididae) in crops in Alberta, 1918-1975. The Canadian Entomologist 109: 575-592.

Stewart, R. 1990. Possible effects of climatic change on estimated crop yields in Canada: a review. *In*: Climate change: implications for water and ecological resources (G. Wall and M. Sanderson eds.). University of Waterloo, Dept. of Geography Publication Series.

Strong, W.L, and K.R. Leggat. 1981. Ecoregions of Alberta. Alberta Energy and Natural Resources, Edmonton. Tech. Report 6.

Strong, W.L. 1991. Ecoregions and Ecodistricts of Alberta. Alberta Forestry, Lands and Wildlife, Edmonton. (In press).

Sutherst, R.W. 1991. Pest risk analysis and the greenhouse effect. Review of agricultural entomology 79: 1177-1187.

3. PRAIRIE CONSERVATION ACTION PLAN

PRAIRIE CONSERVATION ACTION PLAN IMPLEMENTATION IN SASKATCHEWAN

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Before looking at where we are with respect to the plan I wish to make some general comments on plan implementation. In looking back six years the progress is impressive.

The Prairie Conservation Action Plan (PCAP) was a product of World Wildlife Fund (WWF) Canada's Wild West program, a three year, $600,000 funding initiative. The plan for Wild West was announced at the Edmonton Endangered Species Workshop, the first time those concerned about prairie endangered species and spaces met to discuss prairie conservation. Essentially the 10 goals of the PCAP lay out three main courses of action: endangered species recovery, a system of protected areas, and program integration or sustainable development. The goals elaborate on and provide supplements to those directions.

When WWF initiated the Wild West program, active work on endangered species was just starting in Saskatchewan. The species were protected, and some special actions like protection of pelican colonies had been carried out, but there was no systematic identification of problems and development of recovery efforts for threatened wildlife.

The Wild West program was a significant stimulus to that process both by bringing people together to discuss problems and approaches and by providing some dollars for cost shared projects. During the same period the National Wildlife Directors were moving to create RENEW (Recovery of Nationally Endangered Wildlife) and the whole endangered species area was rising in public profile. By the time the PCAP was released, the species part of its thinking was ingrained in our thinking and we no longer needed to refer to a plan.

Unfortunately, the spaces approach showed less success. In part this was because wildlife agencies currently operate from a species mandate. We protect habitat because it is important for a certain species rather than its basic ecological value. Hence we were not in a good position to pursue creation of a series of ecological protected areas. Large areas, of course, are covered in our parks systems plan, which is committed to a park in each of our natural regions. Saskatchewan Environment has the responsibility for broad ecological protection through ecological reserves, but reserves, like parks, have a high level of protection and will not be implemented to cover 10% of agricultural Saskatchewan by 1994.

The recommendation for a system of protected areas by habitat subregion was therefore, allowed to fade from our agendas because it didn't fit into any existing program. We have protected a lot of land toward meeting the goals of the PCAP as I will show in a moment, but it was not because of the PCAP and, as a result, there are gaps. In truth I cannot point to any new actions on spaces which can be directly linked to the PCAP.

This does not mean the plan has been without value. The thought going into the plan certainly helped focus our thinking on prairie conservation and increased the commitment of key players. The PCAP contributed to the rising concern for prairie conservation and thus has been useful.

However, to evaluate the implementation of the plan, a feedback loop is necessary to check regularly on progress against the objectives. Except for this meeting, there has been no follow up or checking on progress by WWF or any of the provincial nongovernment orgauizations in Saskatchewan. We have thus failed in one of the basic principles of planning—regular checks on progress—and the PCAP has tended to slip out of people's minds.

In conclusion, we have made progress as I will now briefly summarize. But as with any plan, more regular follow up, prodding, and support would increase our success. In that regard the current WWF endangered spaces campaign with annual follow up is a step in the right direction.

Now to a closer review section by section.

IDENTIFY THE REMAINING NATIVE PRAIRIE AND PARKLAND

The Terrestrial Wildlife Habitat Inventory has essentially accomplished this task. Accessibility of the inventory and potential for updating are being improved as data is entered in the Wildlife Branch (Wildlife Development Fund [WDF]) geographic information system. This goal has been achieved, however, the product needs updating. Additional work on this goal could involve updating the data and determining the quality of the vegetation on the lands identified. More detailed data will be provided by the Nature Conservancy Data Centre which opens in Regina in March 1992.

PROTECT ONE LARGE SAMPLE OF EACH OF THE FOUR MAJOR PRAIRIE ECO-REGIONS

Agreement with Canada on establishment of the Grassland National Park and current acquisition, by the Canadian Parks Service, of land for the park area, is providing the large mixed grass reserve called for in the plan. Moose Mountain Provincial Park, a long standing area comprised of 96,989 acres and set aside in 1931, provides a large aspen parkland reserve.

ESTABLISH A SYSTEM OF PROTECTED NATIVE PRAIRIE ECO-SYSTEMS ACROSS THE PRAIRIE PROVINCES, INCLUDING REPRESENTATIVE SAMPLES OF EACH ECO-REGION AND HABITAT SUB-REGION

There has been no systematic effort to ensure we meet the goal of protecting lands in the 114 sub-regions. However, there is substantial acreage being protected throughout the province.

At present, of the 111 habitat subregions in the prairie and parkland of Saskatchewan nine have more than the 10% goal in protected status. We have more than 500 ha and less than 10% of another 68 subregions protected and less than 500 ha protected on the remaining 34 sites. Of those 34, seven have more than 10% of their land with sympathetic agencies, that is either in PFRA pastures or provincial Crown land with a policy currently in place to retain it for agriculture. Thirteen of the 34 have more than 500 ha in that status. Thus, although not really a secure protection, these areas have some potential to be considered protected through agreements or extensions of the Critical Wildlife Habitat Protection Act (CWHPA). On 14 sites there is essentially no, or at least less than 500 ha of land with any form of protection. But on at least five of these sites there are 500 ha or more of Crown lands which might be suitable protected areas, but all are currently leased for grazing.

Although this progress in protecting habitat subregions is not bad, there are gaps and the gaps are there for a good reason. These lands were not protected because of the PCAP. Not one acre. The groups that are influential and effective in getting habitat protection have been hunters groups. They have been the primary push behind, and the major contributors to, our protected areas in agricultural Saskatchewan, the 1.9 million acres in the CWHPA and 115,000 acres acquired by the WDF. Parks and protected areas are very important in certain regions and responsible for some of the areas where we exceed 10%, but have not provided the extensive coverage of the programs designed for game management.

If there is a lesson in this it is that our endangered spaces type efforts on the prairies might be most effectively tied to game management's main habitat programs. Secondly, the hunter's lobby remains influential. I think we want to ensure that the endangered species and spaces people form common goals with hunters groups whenever possible to maximize effectiveness.

PROTECT PRAIRIE ECO-SYSTEMS AND HABITATS BY PREPARING AND IMPLEMENTING HABITAT MANAGEMENT PLANS FOR ALL PUBLIC LANDS

Management plans are prepared or being prepared for many public lands including parks, wildlife lands, and some PFRA pastures.

PROTECT AND ENHANCE POPULATIONS OF PRAIRIE SPECIES DESIGNATED NATIONALLY OR PROVINCIALLY AS VULNERABLE, THREATENED, ENDANGERED, OR EXTIRPATED BY IMPLEMENTING RECOVERY AND MANAGEMENT PLANS

Saskatchewan is working through the Committee for RENEW to develop recovery plans for all current threatened and endangered species. These are scheduled to be completed by 1993. Some of these plans are already completed and are being implemented, i.e., the Swift Fox (*Vulpes velox*) release program.

The Saskatchewan Endangered Species Fund has supported 16 projects for conservation of threatened wildlife in Saskatchewan. Total value of these projects has been $255,488.

Habitat for threatened, endangered, or extirpated species found on Crown lands can and has been protected under the CWHPA. Follow up can be quick. Many of the areas where Piping Plover (*Charadrius melodus*) were found in spring 1991 on the international census have been mapped as critical habitat and efforts to provide some protection to these sites are under way.

ENSURE NO ADDITIONAL SPECIES BECOME THREATENED, ENDANGERED, OR EXTIRPATED

This goal is almost impossible to achieve as new species continue to be designated by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) due to better knowledge rather than worsening situations. Our major strategies involve use of environmental impact legislation to screen potential adverse impacts. To aid this process the Wildlife Branch provided Saskatchewan Environment and Public Safety with a list of vulnerable species which could become threatened or endangered if adversely impacted.

We have been working with Canadian Wildlife Service to identify and protect critical areas for shorebirds, loss of which could endanger these species.

The new Conservation Data Centre will collect data on species and ecosystems and make it available to businesses to improve their ability to assess environmental impact and thus ensure that new development will not produce additional threatened species.

ENCOURAGE GOVERNMENTS TO MORE EXPLICITLY INCORPORATE CONSERVATION OF NATIVE PRAIRIE IN THEIR PROGRAMS

The Round Table on the Environment and Economy produced the Saskatchewan Conservation Strategy, still in draft form, which seeks to focus efforts by government, industry, interest groups, and individuals to achieve sustainable development in Saskatchewan.

Saskatchewan has been asked to join the proposed new federal-provincial Agri-food Accord on Environmental Sustainability. As a partner to this accord, the department will seek to incorporate wildlife conservation into the new and modified agricultural policies.

ENCOURAGE BALANCED LAND USE ON PRIVATE LAND THAT ALLOWS SUSTAINED USE OF THE LAND WHILE MAINTAINING AND ENHANCING THE NATIVE BIOLOGICAL DIVERSITY OF THE PRAIRIE

The department and Saskatchewan Wetlands Conservation Corporation are continuing efforts to influence agricultural practices to ensure better soil conservation practices and changes in the municipal taxation system. The department continues to support Operation Burrowing Owl (*Athene cunicularia*) and the Saskatchewan Wildlife Federation's Wildlife Tomorrow Program, both promoting private stewardship of lands.

PROMOTE PUBLIC AWARENESS OF THE VALUE AND IMPORTANCE OF PRAIRIE WILDLIFE AND WILD PLACES

The province is the national leader in implementing Project Wild throughout the school system. All education students at both Saskatchewan universities are now trained in Project Wild and more than half of our teachers have the material. We also work in other areas including soil conservation, urban wildlife initiatives, and media coverage.

PROMOTE RESEARCH RELEVANT TO PRAIRIE CONSERVATION

Little progress has been made toward creation of a grassland research centre. Endangered species research is flowing from recovery teams and plans, other research is tending to come from the traditional directions. We talk, at recovery teams and other places, about the need for some long-term ecological studies, but so far we have not been able to develop such a research program.

To close, I wish to take a look forward to what may happen in the next several years. I expect by the next workshop we will be able to point to increased protected areas in the prairie and continued success with species oriented work. Initiation of a departmental protected areas study and creation of the Nature Conservancy Data Centre will focus attention on gaps in the protected areas network and special ecological areas.

In addition, a growing ecological awareness by agriculturalists and keen interest to incorporate wildlife conservation into their activities provide real hope that we will continue to show real progress in meeting the overall objectives of the PCAP.

IMPLEMENTING THE PRAIRIE CONSERVATION ACTION PLAN IN ALBERTA 1989 TO 1991 - TWO YEARS OF PROGRESS

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Alberta had a unique institutional response to the challenge posed by the Prairie Conservation Action Plan (PCAP), establishing a large multi-partite Prairie Conservation Coordinating Committee (PCCC) to ensure that the goals of the plan are carried out and to encourage cooperation among the various stakeholders involved.

At the time of the second Prairie Conservation and Endangered Spaces Workshop at Regina in January 1989, I was able to inform you of the intention to create this committee, but the committee had not yet been constituted—we held our first meeting in November 1989. Since then we've met six more times over a period of slightly over two years, and there are now slightly less than two years left in the PCAP's 1989 to 1994 5-year "mandate." It is obviously an appropriate time to take stock of what we have achieved to date, to proclaim our accomplishments, to lament our shortcomings, and to look ahead to 1994 and beyond.

In the limited time available I want to focus exclusively on the PCCC and on what it has been able to do in terms of moving the prairie conservation agenda forward. This means that you're not going to get from me a snapshot of how Alberta stacks up today in terms of action toward the 10 PCAP goals. The reason, of course, is that there's lots of ongoing programs and activities being undertaken by both government and nongovernment organizations that are making significant contributions, but that are not related to the existence of the PCCC.

Most of you will not be familiar with the PCCC, so a little background information is in order. Its membership (Table 1), with representatives of all three levels of government, industry, academia, agricultural and environmental groups, regional planning commissions, and nongovernment organizations, makes this the largest committee of its kind in the country. Although initiated by the provincial government, the committee decided it would exist independently of government and established its own agenda. The purposes (Table 2) that the committee has set for itself are self-explanatory. This is the only forum in which groups exercising jurisdiction or having interests in prairie conservation issues can meet to disseminate information, share experiences, build a working relationship, and pursue coordinated responses to common challenges.

The committee also agreed at an early stage to define a list of principles that would characterize its modus operandi (Table 3). This enabled us to nail down consensus on some fundamentals as well as set a tone for the way in which the committee conducts its business.

Obviously with a committee of this kind we were very much embarking on a voyage of discovery and it may be of value to outline a number of the challenges that we face and the way in which we have tried to deal with them.

Team building is a real challenge, both because of the size of the committee and the diversity of values and viewpoints around the table. Our response has been to conduct meetings at "retreat"-like locations in rotating centres throughout prairie and parkland Alberta. This gets everyone away from the office and throws them together in a quasi-social setting. Add in field tours and a wide range of technical and dinner speakers and over a period of time we have been able to build shared experiences, break down some of the more obvious barriers between people, and both impart and exchange a great deal of information.

Running a committee of four dozen people so everyone can feel like a meaningful participant is also a challenge. By mixing plenary discussion and decision sessions with task-focused work groups and round-the-table information updates, all members are provided with good opportunities to participate.

Now at this point I can sense the skeptics amongst you say, since when was the means the end? When does the talk stop and the action begin? Information-sharing, communication, shared experiences, understanding, and bureaucrats on field trips are all wonderful

Table 1. Prairie Conservation Coordinating Committee member agencies.

Agriculture Canada
Alberta Agriculture
Alberta Association of Municipal Districts and Counties
Alberta Cattle Commission
Alberta Community Development
Alberta Energy
Alberta Environment
Alberta Fish and Game Association
Alberta Municipal Affairs
Alberta Recreation and Parks
Alberta Tourism
Alberta Wilderness Association
Battle River Regional Planning Commission
Calgary Regional Planning Commission
Canadian Forces Base Suffield, Department of National Defence
Canadian Parks and Wilderness Association
Canadian Parks Service, Environment Canada
Canadian Wildlife Service, Environment Canada
CN Rail
Coal Association
Coordination Services, Alberta Forestry, Lands and Wildlife
Ducks Unlimited
Eastern Irrigation District
Edmonton Metropolitan Regional Planning Commission
Energy Resources Conservation Board
Environment Council of Alberta
Federation of Alberta Naturalists
Fish and Wildlife Division, Alberta Forestry, Lands and Wildlife
Land Information Services Division, Alberta Forestry, Lands and Wildlife
Natural Resources Conservation Board
Nature Conservancy of Canada

Table 1. (cont.)

Oldman River Regional Planning Commission
Palliser Regional Planning Commission
Public Lands Division, Alberta Forestry, Lands and Wildlife
Recreation Parks and Wildlife Foundation
Red Deer Regional Planning Commission
Regional Co-ordination Services, Alberta Forestry, Lands and Wildlife
Southeast Alberta Regional Planning Commission
South Peace Regional Planning Commission
Special Areas Advisory Council
Special Areas Board
Trans Alta Utilities
Unifarm
University of Calgary
Waterton Biosphere Association
Western Stockgrowers Association
Wildlife Habitat Canada
World Wildlife Fund Canada

things, but what about the acid test—what about preserving prairie? Specifically, what is happening in terms of action-oriented conservation initiatives that would not have happened without the PCCC?

This, of course, is the big challenge, and its one I'm pleased to say that we've tackled head on. Firstly, we keep the goals and action recommendations of the PCAP firmly on the agenda. Each member organization is challenged to identify, for every goal and every action recommendation, what contribution their organization is prepared to make to move the agenda forward. These "member intentions" are recorded in an overall "implementation strategy" document which is updated annually. Member organizations are encouraged to execute their "commitments" diligently and report on progress regularly. In this way the PCCC provides a stimulus to many ongoing programs and initiatives.

Secondly, when there are a lot of commitments on a particular action recommendation, where there is a high level of consensus about what might be done and where there are obvious gaps in what is currently being done, the PCCC will formally initiate a work group to work on producing concrete results. These work groups are the engine that drives the PCCC machine and in the last year we've had two come to fruition with impressive results.

WILDLIFE VALUES TRAINING

In July 1990, the PCCC established a work group comprising representatives from Alberta Agriculture, Alberta Forestry, Lands and Wildlife (Fish and Wildlife and Public Lands Divisions), and Environment Canada (Canadian Wildlife Service [CWS]). The Alberta Association of Agricultural Fieldmen was also invited to participate. The group was chaired by the PCCC's representative from the University of Calgary. The group was charged with pursuing action on the PCAP action recommendation, "Agricultural field personnel, district agriculturalists and wildlife

Table 2. Role of the Prairie Conservation Coordinating Committee.

1. The purpose of the committee is to encourage effective implementation of the PCAP in Alberta and to provide an ongoing profile for prairie and parkland conservation initiatives.

2. The committee will establish a focus and profile for the cooperative pursuit of initiatives identified in the PCAP. It will:

- serve as a forum for information exchange and cooperation between key organizations with interests in or jurisdiction over prairie conservation initiatives;

- allow key contacts to get together periodically to review the plans, projects and programs of member organizations, to assess progress and to integrate program efforts;

- constitute a cooperative partnership between different levels of government and nongovernment organizations in sharing major responsibility for implementing the PCAP, while also allowing both groups to share their experiences and strengthen mutual goals and objectives;

- encourage members to tailor their own programs, policies, or initiatives to meet the goals of the PCAP;

- review progress in implementing the PCAP in Alberta;

- identify gaps and recommend measures to fill them in such areas as inventory deficiencies or new program requirements; and

- adopt media communication strategies as appropriate to ensure that significant initiatives and accomplishments are widely communicated publicly.

3. The committee will encourage coordination and complementarity between major conservation-related initiatives such as the PCAP, the North American Waterfowl Management Plan, the Alberta Conservation Strategy, and Federal/Provincial Soil Conservation initiatives.

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biologists should receive training in the value and preservation of native habitat and all wildlife."

In response to this challenge, work group members organized a training course entitled, "Retaining Native Prairie and Wildlife Habitat in an Agricultural Landscape." The course was conducted as a block course by the University of Calgary's Faculty of Environmental Design in June 1991 at the Brooks Pheasant Hatchery with a registration cost of $175. There were about 30 registrants including habitat biologists, district agriculturalists, resource agrologists, range specialists, soil conservation specialists, and agricultural fieldmen. The conrse outline covered a lot of ground. Course evaluations were extremely positive and a slight profit was realized which was donated to the Antelope Creek Habitat Development Project. The PCCC intends to conduct the course again in 1992. Ultimately it is hoped that up to 200 people can take the course.

PROTECTION ISSUES, CFB SUFFIELD

The PCAP noted the existence of a large area of relatively undisturbed prairie within the Canadian Forces Base (CFB) Suffield and encouraged cooperative conservation efforts to increase protection for flora and fauna. The plan recommended that major portions of the base should enjoy significant conservation status.

The Suffield work group was established in July 1990 comprising representatives from the Alberta Wilderness Association, Alberta Forestry, Lands and Wildlife (Public Lands and Land Information Services divisions), the Canadian Parks and Wilderness Society, the Southeast Regional Planning Commission, and the Special Areas Board. The group was chaired by the Alberta Recreation and Parks representative. The

Table 3. Prairie Conservation Coordinating Committee operating principles.

The following operating principles were adopted by the PCCC at its March 1990 Medicine Hat meeting:

1. The PCCC recognizes that the goal of prairie and parkland conservation has both habitat protection and habitat development components. Explanation: While modified environments are not a substitute for irreplaceable native environments, they are indispensable if the goal of retaining biological diversity is to be achieved. The overriding interest of the PCAP is the retention of natural conservation values. In achieving this intent, the retention of existing remaining native ecosystems (protection and management) and the development of modified environments that provide natural conservation values (e.g., Ducks Unlimited projects) are complementary components of the same task.

2. The PCCC subscribes to the three international principles of the World Conservation Strategy: a) to maintain essential ecological processes and life support systems; b) to preserve genetic diversity; and c) to ensure the sustainable utilization of species and ecosystems. Explanation: Resource utilization and resource protection can both achieve nature conservation objectives. Over most of prairie and parkland Alberta the greatest potential gains can be made by placing emphasis on man conducting resource consumptive activities in a manner consistent with the retention of viable species, communities, and habitats.

3. PCCC members recognize and respect the legitimacy of different values and viewpoints. Explanation: We define a resource as a part of the environment that society values, but as a society and as individuals we value things differently. While espousing our own values, it facilitates our dealings with others if we recognized the legitimacy of other views and refrain from imposing our values as truths or imputing others as base.

4. The PCCC will focus its energies in areas where there is the greatest degree of emerging consensus and where the most progress toward realizing the goals of the PCAP can be made.

5. The PCCC will attempt to work with all stakeholders and will espouse cooperative and not confrontational approaches. The committee will pursue its objectives in a way that respects the livelihood and lifestyles of rural residents.

6. The PCCC subscribes to the principles of integrated resource management. Explanation: The work of the committee will be characterized by adopting a holistic perspective on issues, sharing information and decision-making, undertaking consultation before action, and encouraging coordination amongst stakeholders.

representatives from CFB Suffield and the CWS also played key roles.

There were a number of meetings and a field tour of CFB Suffield was conducted. The extent of the environmental stewardship exercised by the base soon became evident. The base not only has an environmental protection plan intended to ensure that military training activities do not compromise important environmental values, but also designates large areas of the base as off limits to military activity. Two, third party committees annually provide environmental advice relating to oil and gas and domestic grazing activities.

While recognizing this exemplary environmental stewardship, some members of the group continued to struggle with the issue of whether some form of designated protection was appropriate. Various options were considered, including a proposal for a federal-provincial agreement which might establish conservation lands as an ecological reserve. In September 1991, following consultations with CWS, the Department of National Defence (DND) agreed in principle to set aside a portion of the base as a National Wildlife Area (NWA). Consultations are currently underway on the details for establishing such an area. The NWA will remain part of CFB Suffield and will continue to be managed by the DND. In the event of any long-term changes in the status of the base, however, the NWA designation will ensure continued protection of these environmentally significant lands.

The protected area includes the Middle Sand Hills in the northeast section of the base and an area in the southwest corner along the South Saskatchewan River breaks. These areas are prime habitat for the Prairie Rattlesnake (*Crotalus viridus*), Pronghorn Antelope (*Antilocapra americana*), White-tailed Deer (*Odocoileus virginianus*), Mule Deer (*O. hemionus*), and a number of endangered or threatened birds including the Ferruginous Hawk (*Buteo regalis*), Burrowing Owl (*Athene cunicularia*), and Baird's Sparrow (*Ammodramus bairdii*).

Other work groups are currently active dealing with PCAP recommendations on protection issues in southeast Alberta, maintaining wildlife and habitat in municipalities, retaining urban native prairie areas, and environmental education.

There are a number of other areas where real progress has been made toward implementing PCAP goals as a result of collaboration between PCCC members. I'll provide three examples:

1. Early in 1989 a Crown land lessee in the Altario area of east-central Alberta, waving a copy of the PCAP, succeeded in forcing an Energy Resources Conservation Board (ERCB) hearing because she didn't want a well site drilled on her native prairie. In its July 1989 decision report, the ERCB allowed the well to go ahead with special conditions (the well, incidentally, was a duster, and the conditions were carried out to the satisfaction of the lessee) but also recommended that the affected agencies collaborate to develop policy guidelines aimed at affording appropriate protection for native grass prairie environments, consistent with the recommendations of the PCAP, while at the same time allowing reasonable access to oil and gas resources.

Under the coordination of the ERCB, Alberta Fish and Wildlife, Alberta Public Lands, the Land Conservation and Reclamation Council, and the Special Areas Board did just that. A draft of the guidelines was reviewed by the PCCC members and the scope of the projects was extended from just the Special Areas to the entire mixed and fescue grassland portion of Alberta. The guidelines will be issued with an ERCB information letter this month. They require the adoption of minimum impact practices and provide detailed direction to the industry for seismic, drilling production, pipeline, and reclamation activities.

2. For some time, Alberta Forestry, Lands and Wildlife in association with various regional planning commissions, has been promoting the development of Environmentally Significant Areas (ESA) inventories for rural municipalities. These inventories cover both freehold and public land and provide a reconnaissance level overview of ESAs. The relative sensitivity of sites are evaluated and classified according to their regional, provincial, and national importance. They are of considerable value to both the public and private sector for land use management and planning purposes.

The level of interest in undertaking the inventories was always variable and there were areas where no progress was being made. Creation of the PCCC created a level of expectation and peer pressure that provided momentum to "fill in" a lot of blanks. Since the PCCC was initiated, ESA inventories have been initiated or completed for the vast majority of prairie and parkland Alberta.

3. In 1990, the Municipal District of Acadia had a council policy to divest itself of its 84 quarter sections of tax recovery lands. These predominantly native grass prairie lands were to be sold for agricultural development. After hearing about the PCCC through the media, council made contact with the committee. Following initial discussions, the council expressed its willingness to consider other options. An ESAs inventory was undertaken and the council and Alberta Public Lands spent much time working on a land exchange proposal that would meet community, social, economic, and environmental objectives. At present there is agreement in principle to a proposal that would see the vast majority of 84 quarter sections retained as native grass prairie and the old sale policy has been reversed.

The examples are just vignettes, but they do demonstrate that there are a number of important areas in Alberta where applied progress is being made, that would likely not have been made without the existence of the PCAP and the PCCC.

To balance this record of accomplishments somewhat, I think its important to identify some of the impediments to progress as follows:

1. The PCCC has a rather precarious, shoestring existence. No new monies were provided to run the committee and the members themselves fund their own activities. The PCCC does not have staff, library, or research funding capabilities and it is only within the last month that we have managed to get some basic financing arrangements in place to allow for the

costs of holding the meetings and publishing an annual report.

2. Not everyone is wildly enthusiastic about prairie conservation initiatives and the PCCC is a very broadly representative committee. Because the committee operates by consensus, and because it adheres to its operating principles, the committee has not been as progressive or as activist as many members would like it to be. At the same time of course, we have avoided alienating any stakeholders and the initiatives that the committee has pursued have broad societal support.

3. These days everyone is doing more with less and usually more and more with less and less. This strains our ability to resource the activities of the committee effectively and to ensure that the projects we do take on are completed quickly. The list of things that we could be doing is intimidating, but if we over-program our members we run the risk of starting more, but finishing less. To date we've successfully maintained a high level of interest and participation with about three-quarters of the total membership participating actively in every meeting.

I'd like to conclude with a few observations about what is likely to be accomplished over the next couple of years, where we are likely to be standing with regard to the goals of the PCAP, and what might come next.

I expect slow but steady progress from the PCCC. The number of dramatic announcements (e.g., Suffield), is likely to be limited, but the committee will continue to make valuable contributions where needed actions "fall between the cracks" of existing jurisdictions, programs, and initiatives. The committee will more systematically track the implementation of members' commitments, and this, together with the adoption of appropriate communication strategies and special events (such as the Duke of Edinburgh's visit in his capacity as International President of the World Wildlife Fund for Nature) will help to maintain a momentum and profile for prairie conservation initiatives at a time when the political will and financial ability of governments to provide environmental leadership is becoming more limited. The networking linkages between member organizations will likely continue to provide a catalyst for various cooperative conservation initiatives.

By the end of 1994 I anticipate we will have seen significant progress toward the accomplishment of many of the PCAP's goals but we will be a long way from home. I think it will also be evident at that time that there are some areas where we are not making any real progress and others, overlooked by the PCAP, where we are. This likely adds up to a need to document what has been achieved, refine the strategy, and launch a revised prairie conservation campaign. This iterative approach is time consuming, but necessary, if we are to continue to remain relevant and effective. One thing is for sure—we won't be able to rest on our laurels.

SASKATCHEWAN WILDLIFE HABITAT STATISTICS (1976 TO 1990)

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BACKGROUND

This paper summarizes several habitat loss findings encountered while reviewing various habitat projects and proposals generated by Wildlife Branch, Saskatchewan Natural Resources (former Saskatchewan Parks and Renewable Resources), between 1984 and 1990.

A limited amount of information is available on Saskatchewan's wildlife habitat base. This presents a significant problem for wildlife managers. The Terrestrial Wildlife Habitat Inventory (TWHI), conducted in Saskatchewan between 1975 and 1983, still provides the best information on how much "critical" wildlife habitat exists and where it is located. However, significant habitat loss has occurred in many areas of the province since this inventory was conducted. Habitat loss has resulted in an ever-decreasing supply of prairie wildlife, and is the major cause of wildlife species becoming threatened or endangered.

ASSUMPTIONS

For the purpose of this report, native vegetation lands, native lands, and unimproved lands are assumed to provide wildlife habitat. The percent, or amount, of land remaining in a native vegetation condition is assumed to reflect the amount of remaining wildlife habitat, as indicated in the following nine sources or studies.

RESULTS

In March, 1988 a startling example of habitat loss came to light during preparation of a (Fish) and Wildlife Development Fund Proposal: "Conservation of White-tailed Deer Winter Habitat in Southeastern Saskatchewan" (Wildlife Management Zones [WMZ] 16, 31, 32, and 34) (Weins 1988). Examination of 1979 to 1980 Saskatchewan Property Management Corporation photomaps revealed that only 8,100 acres, or 1.17% of WMZ 32 remained in White-tailed Deer (*Odocoileus virginianus*) winter habitat, (land parcels dominated by native Aspen [*Populus tremuloides*] cover, 40 acres and larger, Appendix 1). Habitat objectives calculated for this WMZ (Zone Area = 689,000 acres) indicate that about 32,000 acres of White-tailed Deer winter habitat are needed to sustain desired deer populations for consumptive and non-consumptive use. I speculate that the amount of remaining winter habitat is a limiting factor to White-tailed Deer population growth in WMZ 32.

The booklet "Lets leave some Wild in the West - Prospectus For A Prairie Conservation Action Plan" (World Wildlife Fund 1987) states that, "a 1978-82 census showed that the areas of our five types of natural prairie had been markedly reduced in size." Only 18% of the shortgrass prairie, 24% of the mixed grass prairie, and 25% of the aspen parkland areas remain in a native condition. Areas not already cultivated may have been damaged owing to the demands placed on the land by continuous grazing, especially during the drought years of the 1980s. In Alberta only 22% of the fescue prairie remains, while in Manitoba less than 2% of the tall grass prairie persists. Present wildlife populations are relying for survival on less than one quarter of their former native landscape.

Sugden and Beyersbergen (1984) looked at 101 quarter sections of aspen parkland in east-central Saskatchewan and found that, excluding wetlands, 82.7% of the entire area was cultivated annually. Of 156 public road allowances examined, two-thirds were partly or entirely used for private farming practices.

According to the 1986 Statistics Canada Census land use data for Saskatchewan (Appendix 2), 49.53 million of 65.73 million acres (75.4%) reported by farmers have been improved (assumed cultivated). Of the 16.2 million acres reported as unimproved (assumed wildlife habitat), 13.34 million are rated as unimproved pasture; 0.38 million are reported as woodlands, and 2.48 million are reported in the "other unimproved" category (areas of native pasture, brush pasture, grazing or wasteland, sloughs, marshy, and rocky land). Comparing the 1986 figures to former Statistics Canada figures yields information on the decreasing wildlife habitat base (Table 1).

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Table 1. Increases in improved land - 1951 to 1986 (Statistics Canada).

Census Year	% of Land Reported as Improved	% of Land Reported as Unimproved	
	Cultivated	Woodland	Other Unimproved
1951	62.9	4.8	32.3
1961	66.9	3.4	29.7
1971	71.4	1.5	27.1
1981	75.9	1.1	23.0
1986	75.4	0.6	24.0

Although the reported percentage of cultivated land between 1981 and 1986 stabilized at approximately 75%, the static nature can be attributed to the different total and improved acreages reported by farmers in the two census years. In 1981, 67,318 farmers reported 48,639,871 acres as improved whereas in 1986, 63,431 farmers reported 49,530,723 acres as improved. This increase in improved land (890,852 acres), divided by the reported unimproved acres (15,476,808) remaining in 1981, yields a habitat loss figure of 5.76% from 1981 to 1986, or 1.15% per year (Appendix 13). This 1.15% loss per year compares with a 1.23% loss per year calculated from Saskatchewan Municipal Assessment data (1976-1985).

The 1986 Statistics Canada data on land use was also used to calculate 1981 to 1986 habitat loss figures for five grassland 1:250,000 map sheets: Willow Bunch Lake (10.56%), Wood Mountain (5.93%), Cypress (8.06%), Prelate (4.36%), and Swift Current (12.72%) (Appendix 14). Overall grassland habitat loss indicated was 7.88% from 1981 to 1986 or 1.57% annually.

Milliken (1980) studied habitat loss on a 407 mi^2 block in southwestern Manitoba from 1971 to 1979. He reported a 19% reduction (4,938 acres) in White-tailed Deer winter range from 1971 to 1979. Overall reduction in native vegetation (summer and winter range) equalled 17% (15,418 acres). Habitat loss on private land, vulnerable to clearing, amounted to 22% over the eight years. Nine percent of the municipal rights-of-way had been bulldozed and 3,320 wetlands were lost to bulldozing, cultivation, or drainage during the eight years. Crown lands in the study area accounted for 12.6% of the deer winter range, but supported 28.2% of the wintering deer herd.

A 1981 study conducted in Saskatchewan by Stewart and Longmuir (Wildlife Population Management Bulletin 82-3 Appendix 3) (Stewart 1982) reviewed 1977 to 1981 habitat loss in the Weyburn, Melville, and Yorkton NTS 1:250,000 map sheet areas. Of 13,880 acres examined on the Weyburn map area, 2,280 acres or 16.4% had been cleared in four years. On the Melville and Yorkton map areas 9,840 of 44,480 acres (22.1%) had been brushed. On 6,400 acres of Crown land, 320 acres (5%) had been cleared whereas 1,800 of 6,800 private acres (26.5%) had been bulldozed. Annual habitat loss occurred at a rate of 4.1%. On Crown land the annual loss was 1.25%, while on private land the loss was 6.6% annually from 1977 to 1981.

A 1986 study conducted in southeast Saskatchewan (Rural Municipality [RM] of Antler, No. 61) by the Prairie Pothole Project coordinator, R.D. Russell, estimated that 44,300 acres of native habitat existed in 1986 (based on 19,968 non-cultivated pond acres and 24,336 non-cultivated upland acres) (Russell 1986 Appendix 4). This figure compares well with three other independent estimates of remaining wildlife habitat in this area:

1. Statistics Canada (1987) data for 1986 indicates that 202 farms in the RM of Antler No. 61 reported 45,147 (22.18%) unimproved acres. Surprisingly only 484 acres (1.07% of the unimproved area) were reported as woodland. This represents only 0.24% of the total RM area.

2. Based on Stelfox's (1979) TWHI estimate, there was 28% native habitat in the Redvers-Maryfield-Kelso area in 1977 and 0.9% annual habitat loss. Russell (1986) projected these figures to yield a second estimate of 50,709 acres in native vegetation.

3. Based on evaluation of the 1986 Statistics Canada data for the Carlyle-Redvers-Maryfield area, the rate of habitat loss was 1.6% per year (Statistics Canada 1987). Projecting this rate through to 1986, Russell (1986) calculated another estimate of 46,779 acres remaining native.

Municipal Assessment Authority Data 1976 to 1985

Cultivated acreage data obtained from the Saskatchewan Assessment Management Agency (former Saskatchewan Municipal Assessment Authority; Appendix 5) was used to calculate Saskatchewan habitat loss from 1976 to 1985. Twenty-five rural municipalities exhibited habitat loss greater than 30% over these 10 years. I assumed the assessment data was applicable to loss of upland native vegetation since the figures were generated from increases in cultivated acres, 1976 to 1985. Table 2 gives selected habitat loss figures for 17 of these 25 RMs and Table 3 summarizes this Saskatchewan Municipal Assessment Authority data.

Assuming 25,287,932 acres of native vegetation (wildlife habitat) existed in 1976 and a loss of 3.1 million acres up to 1985, this yields a provincial loss of 12.32% over the 10 years. Appendices 6, 7, and 8 show corresponding 10 year habitat loss figures of 15.1% in the forest fringe; 5.9% in the grasslands; and 13.5% in the southeast parklands. Appendix 9 illustrates the top eight ranking RMs in terms of habitat loss (1976 to 1985). Appendix 10 gives the rate of loss for seven selected Member Legislative Assembly constituencies using the Saskatchewan Assessment Management Agency figures.

Table 2. Rate of habitat loss for selected rural municipalities in Saskatchewan 1976 to 1985 (Saskatchewan Assessment Management Agency).

RM	Total acres in RM	Cultivated acres prior to 1976	Acres assumed native in 1976	Cultivated acres by 1985	% of RM cultivated by 1985	% loss in native acres 1976-85
45	207,030	152,125	54,905	177,768	85.9	-46.7
211	234,520	126,737	107,783	174,318	74.3	-44.1
219	252,530	179,684	72,846	207,684	82.2	-38.4
241	198,820	91,200	107,620	127,013	63.9	-33.3
243	206,130	132,203	73,927	161,341	78.3	-39.4
247	213,290	126,914	86,376	158,053	74.1	-36.1
286	181,270	149,704	31,566	163,963	90.5	-45.2
321	137,440	69,607	67,833	110,335	80.3	-60.0
336	245,236	156,212	89,024	196,649	80.2	-45.4
339	206,270	167,689	38,581	183,420	88.9	-40.8
344	523,130	166,291	356,839	370,966	70.9	-57.4
403	228,360	171,455	56,905	192,265	84.2	-36.6
428	203,720	152,100	51,260	170,354	83.6	-35.4
429	208,590	149,211	59,379	170,287	81.6	-35.5
456	155,490	113,418	42,072	130,368	83.8	-40.3
487	207,050	137,792	69,258	160,177	77.4	-32.3
490	130,790	87,792	42,998	104,244	79.7	-38.3

Table 3. Summary of native vegetation loss in Saskatchewan 1976 to 1985 (Saskatchewan Assessment Management Agency).

All RM Acreage	Cultivated Acres Prior to 1976	Cultivated Acres Reported in 1985	Increase in Cultivated Acres 1976-85
67,754,362	42,466,430	45,582,285	3,115,855

(Fish and) Wildlife Development Fund (FWDF) Saskatchewan Natural Resources (SNR) habitat purchase effort in southeast Saskatchewan 1989 to 1990

In July 1989, SNR hired a land negotiator to work in southeast Saskatchewan in an attempt to implement phase one of the southeast deer proposal. The proposal indicated there were 33 habitat parcels larger than 40 acres in WMZ 32, totalling 4,740 acres which landowners might be willing to sell to the FWDF. In WMZ 34, habitat was divided into two priority areas for possible purchase. The priority one area held 99 land parcels containing 13,470 acres of vulnerable winter habitat. Priority two area vulnerable habitat totalled 44,705 acres in 161 separate parcels. Between July 1989 and September 1990 the land negotiator inspected 139 priority land parcels: six in WMZ 31, 30 in WMZ 32, and 103 parcels in WMZ 34 (Appendix 11).

Review of 1979 aerial photomaps for these 139 parcels indicated 15,820 acres of native wooded habitat. Land inspections and interviews with landowners in 1989 and 1990 indicated that only 9,667 acres remained wooded and that 6,155 acres had been cleared and/or cultivated. Net habitat loss for the 1980 to 1990 period is 38.9% or, 3.9% annual reduction in deer winter habitat.

SUMMARY

There are about 67 million acres in agricultural Saskatchewan, south of the provincial forest. By 1986, 75.4% of this landscape had been modified leaving 16,198,000 acres (24.6%) of "unimproved" land to provide wildlife habitat. Only 377,000 acres or 0.6% of the native landscape remained in woodland in 1986.

The TWHI conducted from 1975 to 1983 indicated there were 3.44 million acres of provincial Crown "critical" habitat (Appendix 12) representing, in 1983, one-third (33%) of the total "critical" habitat in agricultural Saskatchewan. Total "critical" habitat estimated in 1983 was 10.4 million acres.

If habitat loss has remained constant to 1992 one can assume provincial losses of native lands to be at least 1.15% per year. Applying this 1.15% rate of loss from 1986 to 1991 yields 15,287,500 acres remaining native and supplying wildlife habitat in 1992.

The most recent habitat loss figures for parkland Saskatchewan (southeast FWDF effort) indicate 38.9% woodland loss from 1980 to 1990.

Knowledge of the amount and distribution of remaining wildlife habitat will help target habitat retention and enhancement programs in landscapes where the greatest benefits to wildlife can be expected.

Continued wildlife habitat loss in Canada's prairies will result in more endangered wildlife species and threaten our prairie biodiversity.

Note: Copies of Appendices 1 through 14 are available from Wildlife Branch, Saskatchewan Natural Resources, 3211 Albert Street, Regina, Saskatchewan S4S 5W6 or from the author.

LITERATURE CITED

Milliken, I.J. 1980. If deer are to survive - A habitat loss study in southwestern Manitoba. Manitoba Dept. of Natural Resources, Winnipeg. Manuscript report No. 80-33.

Russell, R.D. 1986. R.M. of Antler acreage estimates. Sask. Parks, Recreation and Culture, Regina. Unpubl. report. 14 pp.

Saskatchewan Municipal Assessment Authority. 1987. Unpublished tables - cultivated acres by rural municipality from pre-1976 municipal assessments. Regina.

Statistics Canada. 1987. 1986 Census. Farm area and use of land, 1986. Ottawa.

Stelfox, H.A. 1979. Terrestrial wildlife habitat inventory of the Weyburn (62E) - Virden (62F) map area. Wildlife technical report. 79-6. Saskatchewan Tourism and Renewable Resources, Regina. Unpublished 213 pp.

Stewart, R.R. 1982. Critical wildlife habitat loss in southeast Saskatchewan. Wildlife population management bulletin 82-WPM-3. Sask. Tourism and Renewable Resources, Regina. Unpublished.

Sugden, L.W. and G.W. Beyersbergen. 1984. Farming intensity on waterfowl breeding grounds in Saskatchewan parklands. Wildl. Soc. Bull. 12(1): 22-26.

Weins, T.W. 1988. Conservation of white-tailed deer winter habitat in southeastern Saskatchewan. Saskatchewan Parks Recreation and Culture, Regina. Unpublished. 8 pp.

World Wildlife Fund. 1987. Let's leave some wild in the west. Prospectus for a prairie conservation action plan. WWF Canada, Toronto. Booklet. 12 pp.

USE OF REMOTE SENSING IN THE MAPPING OF HABITAT ON THE CANADIAN PRAIRIES

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INTRODUCTION

The prairies, including Saskatchewan, are experiencing significant changes in agriculture and the resource industries. At the same time, we are required to do more with less in our approach to resource management. Computer technologies are beginning to play major roles in this management. One of the most significant is the use of Geographic Information Systems (GIS) technology to store, analyze, and manipulate geographical and tabular data.

One additional technology that offers considerable promise to resource planners is remotely sensed images and, in particular, satellite imagery and the accompanying technologies of visual and digital analysis.

This paper briefly looks at types of satellite data available, discusses the forms in which it is commonly used, and explores the weaknesses and strengths of the technology for future resource planning.

REMOTE SENSING

What is Remote Sensing?

Remote sensing is the science of viewing something from afar. In other words, it is ability to study an object without coming in direct physical contact with it.

Remote sensing, when it involves satellites, deals with the collection of reflectance information from the earth by sensors on board specific satellites, and the transmission of the information in digital form back to earth. Both digital and manual interpretation of data are then used to describe some characteristics of the earth's surface such as: land cover, fault line locations (geology), ice structure (Arctic shipping), etc.

Types of Satellite Data Available

Numerous satellites are presently orbiting the earth. However, data from four general sources are likely to be used in the future. The two most commonly used data sources are derived from satellites which presently orbit the earth in a near polar path approximately 650 kilometres above the earth's surface. The American LANDSAT series, return to the same area on a 16 day repeat cycle. Cloud cover plays a major role in determining how often you are able to get useable image data for a particular region.

The SPOT satellite, launched within the last two years has a 26 day repeat cycle, but has the added advantage of a reflecting mirror which can "look back" at areas that were covered in cloud during previous orbits. This satellite, therefore, has the capabilities of imaging the same area potentially 14 days out of 26.

Another satellite group, National Oceanic and Atmospheric Administration, provides broad coverage of the earth with a 12 hour repeat cycle. Data from these satellites are commonly seen during television weather reporting and are presently used for mapping or monitoring large regional areas (e.g., drought monitoring).

A fourth group, dealing with the collection of radar data, includes an EOSAT recently launched by the European Space Agency and Canada's RADARSAT which is to be launched in 1994. Radar data has the advantage that it can "see" through cloud. It has its own specific problems and lacks the reflectance gathering capabilities of the previous mentioned sensors. It will likely find its use in land cover mapping in combination with other sensor data.

Data Reception and Description

The data is sent to earth in digital or numeric form. A receiving station just outside Prince Albert, Saskatchewan is the site for the collection of image data for most of Canada, the northern states, and Alaska for both the LANDSAT and SPOT satellites. A second receiving station has been built, in the last few years, in eastern Canada at Point Claire, Québec.

All satellite data purchases for Canada are channelled through RADARSAT International, recently established in new headquarters in Richmond, British Columbia.

Sensors on board the satellites acquire reflectance information from the earth in a grid format. Each grid cell is called a pixel or picture element. It is the size of these pixels that determines the "resolution" of the satellite. For example, sensors on board the LANDSAT 4 and 5 satellites include: the Multi-Spectral Scanner (MSS) sensor with its 58 x 79 metre pixels and the Thematic Mapper (TM) sensor which acquires 30 x 30 metre pixel data.

The French SPOT satellite is capable of imaging the earth's surface reflectance in 10 metre single channel Panchromatic (black and white), as well as simultaneously acquiring data in a 20 metre Multi-spectral data (colour) format.

Data is purchased in the form of computer compatible tapes or hard copy prints or transparencies. The image area is described as a scene or one quarter (quadrant) of a scene. A single scene of TM or MSS data covers an 185 x 185 kilometre area while SPOT images cover an area about 1/6 as large.

Although the spatial resolution of SPOT is superior to TM data, it has poorer "spectral" resolution. The six versus four channels of reflectance information, acquired by the TM sensor, tends to have better capabilities when it comes to separating different vegetation cover types.

This attempt to separate or classify different cover types on the ground is one of the major uses of satellite data and is the use I will discuss in this paper.

The Vegetation Classification Process

Canada is a world leader in the development of computer software suitable for the analysis of satellite, or in fact, any digital image data. The two systems most commonly used are the ARIES series sold by the DIPIX company in Ottawa and the PCI software sold by the company of the same name, also with head office in Ottawa.

Both software systems offer algorithms which are capable of image enhancement and image classification. The classification process, in simplified terms, involves "training" the computer to recognize and tag pixel areas with similar reflectance values. This is accomplished by outlining the location, on the image, of known areas of particular cover types. These are referred to as "training areas." The software program then searches the image for similar reflectances. Each reflectance grouping is called a theme, or class, and corresponds to a cover type chosen by the systems operator.

The final products of a classification can be colour hard copy maps, transparencies, or computer "thematic" files suitable for transfer into a GIS system. It is this latter possibility that is arousing considerable interest in recent times.

In addition to the digital analysis of the data, it can also be interpreted manually in a similar manner to air photos. SPOT even has some stereo viewing capabilities.

The fact that the data is digital, provides some significant advantages. Subsequent information in the form of additional scenes of data, past or future, can be "corrected" in such a manner that they are aligned with existing data. Investigations such as "change detection" can then be done in an operational sense.

Change detection is a process where multiple images are obtained for the same area. Either previous conditions are studied and compared to present conditions, or future imagery is purchased periodically to monitor changes that are occurring over time. An obvious example would be the monitoring of the loss of native grassland areas. Reliable data from the LANDSAT satellites is generally available from about 1975, although the first LANDSAT satellite with a MSS sensor on board began to send data back to earth in 1972.

As you might expect from discussions about change detection, it is also relatively easy in a mechanical sense to call up data then refine and extend a classification that has been generated through digital means. In addition, companies in the business of developing and supplying software and hardware packages to the remote sensing community have developed relatively good operational colour plotting capabilities.

It is interesting to note that this has not been the case with the GIS technology which tends to have relatively poor mapping capabilities. One means of alleviating this problem is the use of computer links, not only to transfer remotely sensed data and its digital products to GIS, but now to transfer GIS data directly to plotters developed for use with image analysis systems.

The ability to quickly and relatively cheaply produce colour maps is a very significant requirement where digital data is to be used in a management role. Previous to the development of these technologies, most mapping and virtually all colour mapping was duplicated by lithographic means. Minimum runs of 1000 or more copies were required for any feasible economies of scale. Set up and printing were both labour intensive and very time consuming, resulting in few updates and therefore, outdated maps.

The new technologies have resulted in virtually real time map development and printing, and although the per map charge is relatively high ($20-$85/map), the actual investment is low, as limited runs of maps are feasible. Frequent updates are both feasible and relatively easily accomplished simply by making the necessary changes in the digital file and re-printing the map. Scale is also of less importance and most plotting software and hardware have a "dial your own scale" approach to handling scaling demands.

With these glowing capabilities why is satellite data not used extensively in resource management today?

There are a number of reasons for our slowness to adopt the use of satellite data in an operational sense. The data is initially expensive and in order to realize its full potential, digital analysis, via the specialized computer software, is required. Analytical systems are expensive to purchase or to obtain the services of private systems and operators. The software programs are complex and extensive and require a considerable "learning curve."

Satellite data is relatively new technology. In the 1970s when it was first available, it was over-sold and made many resource managers "gun shy" about its use. Because the data represents a substantial investment, it is often difficult to justify. Since, at least in its initial use, it often does not replace an existing method of management, but rather acts as a supplemental data set. The use of remotely sensed data in the form of satellite imagery, requires GIS technology as an additional tool to really become attractive.

Why Then Use Satellite Data?

Although the data appears expensive at the time of purchase, it covers large areas (in comparison to air photos) and can usually be obtained in an up-to-date form. Digital classification provides perhaps the only means of mapping large regional areas in a practical time frame. Traditional mapping that would take years to complete, and would often be outdated before completion, can be done in much shorter periods of time with the aid of satellite data and digital analytical techniques.

To put things into proper operational perspective, the following example can be used. Vegetation cover mapping of the entire forested, or conversely, cultivated region of Saskatchewan could be completed in a little over one year with the aid of satellite data. This would require many years to complete using traditional air photo techniques. As might be expected the cost of the former method would also be significantly lower.

The mapping "capability" of the satellite data is admittedly coarser than that which is capable by air photo interpretation. However, this must be weighed against cost, time constraints, and any updating programs that may be envisioned. The requirement for updated information should be weighed against the need for more detail when reviewing management needs. Extreme detail is often less important than the availability of recent inventory data. A more detailed look can often be restricted to specific regional areas, when it is required for additional management decisions.

The worst case scenario occurs when resource managers, waiting for the perfect data set which has both an unrealistic and unattainable price and unworkable time frames, end up with little information to assist them with their management concerns. Questions that should therefore be asked are: what are my objectives?; what level of detail is required?; what is my budget?; what is my time frame?; and last, what are my future plans for the program and how should I design, run, and update this program?

The problem concerning "too much detail" will soon become very apparent as managers begin to use GIS technologies for both the storage and analysis of resource data. A small increase in the data base size is reflected in a large increase in the size of the computer files; the increase generally being geometric in its effect. Very quickly, managers will have to pick and choose what portions, what data bases, and what resolutions they really require for their particular problem.

For their particular problem, here, possibly, lies the answer to some of the problems inherent in the use of satellite data. Is it necessary to purchase data specifically for one group's problem, or is it perhaps better and more feasible to participate in joint purchases with other users? The question is, in fact, rhetorical and it is indeed possible, feasible, and in fact, very desirable to "share" data and data processing with other users. The problem of relatively high up-front cost, although not disappearing altogether, certainly takes on a low profile when this is done.

Many resource managers have surprisingly similar aims, or, at least, work with the same or similar data sets. This is really not all that surprising when you look at an ecosystem approach; if you pluck one strand of the spider web (ecosystem) the rest of the web begins to vibrate, signifying that the strings (ecosystem components) are all attached and affected by changes to each other.

A forest fuels map used by forest managers in northern Saskatchewan has many of the components of a wildlife habitat map, or a land use map similar to that which those involved in tourism planning might require. In the south, an existing vegetation cover map is useful to the wildlife manager, but equally useful to those who are attempting to assess and prevent soil erosion on the prairies. Day-to-day management problems faced by people, such as crop insurance, also find uses for the cover data in their development of programs which provide fair assessment of insured losses of crops, forage, and pastures in a timely and economic manner. Those involved in the fight for endangered species or habitats may well have interest in only some components (classes) of a vegetation classification.

A satellite data set is also of interest to totally unrelated groups such as power authorities, mining, and petroleum industries which must make educated decisions on future development; decisions that hopefully (and the hope is theirs as well as the conservationist) avoid or reduce environment impacts. Avoidance spells savings for all groups concerned.

Digital forms of databases therefore, allow us to modify, select, and use portions of, or all of a data base. They allow us to incorporate the information readily in computer systems such as a GIS. Associated technologies provide us with the abilities to produce up-to-date maps, photographic products, and tabular files (such as area calculations). They are one of the tools of the future to assist us in making fewer mistakes, through educated decisions. They represent a means of applying regional concerns to management policy on a provincial, as well as national scale. The challenge for the future is to find economical means of accessing and using the data for the betterment of mankind and the world around us.

LAND COVER CHANGE IN THE ANTLER MUNICIPALITY, SASKATCHEWAN 1986 TO 1990

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In 1986, Saskatchewan Natural Resources (SNR) (1987) selected the Rural Municipality (RM) of Antler as the site of the Prairie Pothole Project to conduct a pilot study of the effectiveness of various landowner incentive programs to retain or enhance waterfowl nesting habitat. These measures were implemented to counter land use impacts in a region identified as a high capability waterfowl producing area (Stoudt 1971), but where the integrity and quality of waterfowl habitat is threatened by ensuing land use trends. The goals of this habitat restoration project were to encourage the preservation of native vegetation along with wetlands and to restore nesting cover to foster improvements in waterfowl recruitment by encouraging increased homing and nesting success. In conjunction with the habitat restoration program, SNR and the Canadian Wildlife Service (CWS) implemented an evaluation program to monitor habitat trends and responses of waterfowl populations to natural and man-made habitat changes in the experimental area (RM of Antler), compared to an untreated control area (RM of Walpole and Maryfield). This study provided an opportunity to monitor, during the course of a drought (1987 to 1990), land cover change related to land use over an extensive area.

A quantitative baseline inventory of the spatial amount and distribution of remaining native and improved perennial vegetation cover, including the extent of existing wetlands, are prerequisites to monitoring land cover change as modified by weather patterns and land use. The objectives of this study are: 1) to collect baseline habitat data from sampling sites, comparing land cover distribution as measured from linear transects and 65 ha sample plots; 2) to monitor land cover change (1987 to 1990) and compare trends between the experimental area and the neighbouring control area; 3) to estimate the amount of perennial vegetation cover in the Antler municipality and relate it to the amount of improved and protected vegetation cover influenced by the habitat restoration program.

STUDY AREAS

The Antler municipality comprises 808 km^2 (312 mi^2), compared to the control area which comprises 311 km^2 (120 mi^2). The study areas are located on hummocky low-relief moraine which is intersected by several south-trending, gravely outwash channels containing intermittent streams such as Antler River and Gainsborough Creek. Wetlands are dominant features of the landscape as expressed in densities of about $85/km^2$. Developed upon medium textured and calcareous glacial till or fluvial sediments, the Oxbow loam to sandy loam soils (Anderson and Ellis 1978) are highly arable and productive, being suitable to annual cereal and oilseed crops with scattered forage and pasture lands. According to the 1986 Census of Agriculture (Statistics Canada 1987), the total area of improved land comprised about 64,088 ha or 78% of the available farmland in the municipality. Another sampling survey estimated annual cropland at 75%, forage land at 4.5%, and grazing land at 6.5% of the municipality (Millar 1988). Approximately 2850 ha of unimproved Crown land, including critical wildlife habitat lands, also occur. These lands, as well as grazed pastures, are situated along stream channels and contain some of the last remaining large blocks of aspen parkland habitat.

SURVEY METHODS

An extensive habitat monitoring system was designed to assess changes in land cover over the experimental and control areas. The study areas were stratified into representative landscapes onto thematic mapper imagery (Ducks Unlimited [DU]) to depict gradients in wetland densities and percent of land cultivated. The experimental area was divided into 11 landscape areas and the control area into five landscapes; each landscape was sampled by one transect, 12.8 km by 0.4 km, for a total area of 5.2 km^2. The combined transects sampled 83 km^2, or 7% of the study areas (Figure 1). Within each landscape, the transect was positioned on useable roads to facilitate travel and to conform to techniques adopted for air-ground census of waterfowl and habitat assessments [United States Fish and Wildlife Service (USFWS) and CWS, 1987]. Joint crews from SNR and CWS conducted waterfowl counts and assessed land use impacts to wetlands on each transect.

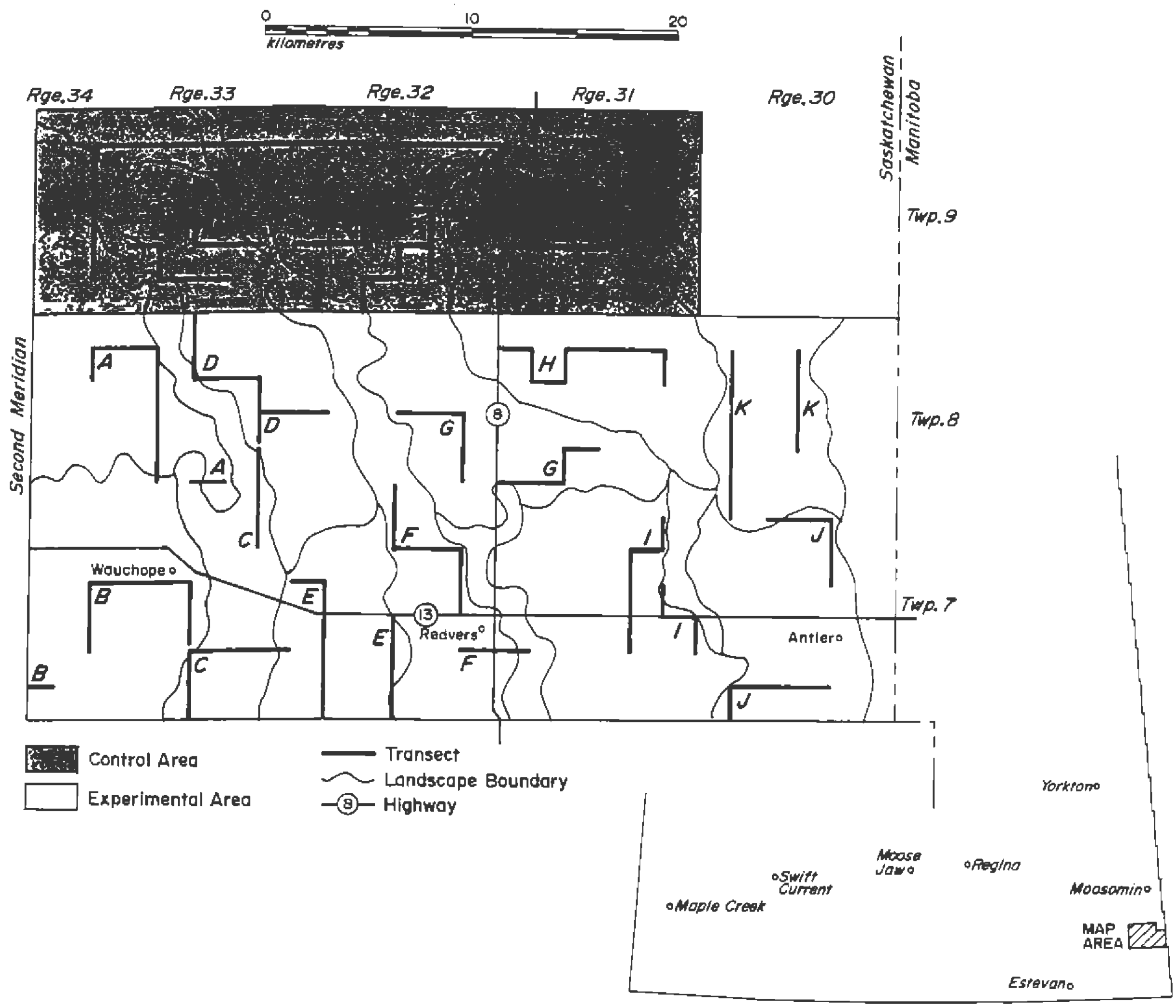

Figure 1. Location of Prairie Pothole Project showing control and experimental areas and transects.

In July 1986, DU furnished complete aerial photographic coverage (colour infrared film), at a scale of 1:20,000, of the experimental and control areas. Enlarged black and white prints (1:10,000), reproduced from mylar transparencies, were used as field maps to assess habitat conditions and to ground-truth 25% of the sampled area. Subsequently, cover maps (1:6,000) were prepared of the 16 transects from the original aerial photographs using the Procom 2 map transfer projections. Using photo-interpretation, CWS mapped, scaled, classified, and digitized polygons on each transect segment (1.6 km) to a minimum size of .01 ha. Cover maps were verified by field checks in July and September, 1987, and maps were corrected and updated. Polygons were coded into categories of cover classes such as wetland, woodland, grassland, disturbed land, annual crops, forage, farm sites, industrial sites, denuded areas, excavated areas, and rights-of-way. These procedures were repeated in 1990, with the acquisition of 1:6,000 colour infrared photography of the transects, except that photographic mylars were used as base maps. Digitized information on cover classes was entered and stored in computer databases. The two databases were processed, and registered, and changes in areas of cover classes were computed.

In 1987 an additional mapping survey of land cover was undertaken in the Antler municipality of 24 sample quarter section (65 ha) plots, distributed along a 19 km flightline segment. Cover maps prepared from interpreted 1986 aerial photographs, were classified, coded, and digitized and the plots were surveyed to develop baseline habitat data for the Prairie Habitat Monitoring Project (Millar 1988). This project is part of a prairie-wide monitoring network associated with USFWS air-ground waterfowl survey transects.

1987 COMPOSITION OF LAND COVER CLASSES

Comparison Of Survey Methods

Independent survey estimates, of the distribution of cover classes on uplands, were compared between the Prairie Pothole and the Prairie Monitoring studies (Table 1). The two studies surveyed approximately 7% and 2% of the municipality area respectively, yet the results of grouped classes are very similar. The percent cover of native grass may be inflated somewhat by additions of grassy wetland margins, which usually have mixtures of introduced species such as Awnless Brome (*Bromus inermis*), Quack Grass (*Agropyron repens*), Crested Wheat Grass (*A. cristatum*), and Kentucky Bluegrass (*Poa pratensis*). Upland native grasses include Bluejoint Wheat Grass (*Agropyron smithii*), Slender Wheat Grass (*A. trachycaulum*), Tufted Hair Grass (*Agrostis scabra*), Canada Bluegrass (*Poa compressa*), and less common species such as Green Needle Grass (*Stipa viridula*), Blue Grama (*Bouteloua gracilis*), and Little Bluestem (*Andropogon scoparius*). Right-of-way grasses were grouped with the introduced, or tame grasses.

According to both surveys, total grassland occupies about 19% of the available upland area (excluding wetlands) (Table 1). The Prairie Pothole Study indicates a slightly higher percentage of woodland, due to the more widely dispersed samples that may intersect more wooded stream reaches than the quarter section plots. Wetlands which numbered more than 4800 on the transects, comprised 14.5% of the sampled area, compared to 16.7% of the sampled plot areas in the monitoring study (Millar 1988). Both surveys produced almost identical estimates (75%) of the proportion of upland cultivated. Agriculture census data, unadjusted for wetlands, indicate that 78% of the total farmed area was improved in 1986 (Statistics Canada 1987).

Table 1. Independent survey estimates of distribution of upland cover classes, Antler municipality, 1986 to 1987.

	Prairie pothole study		Prairie habitat monitoring[1]	
Class	Area (ha)	Upland area (%)	Area (ha)	Upland area (%)
Native Grass[2]	515	10.6	138	10.4
Tame Grass[3]	416	8.5	114	8.6
Woodland	234	4.8	52	3.9
Other[4]	74	1.5	27	2.0
Cultivated	3,634	74.5	993	75.0
Unimproved[5]	783	16.1	200	15.1
Total Upland	4,873		1,324	
Total Wetland	825		266	
Area Sampled	5,698		1,590	

[1]Prairie habitat monitoring results adapted from Millar (1988).

[2]Native grass includes native upland and wetland margin grasses.

[3]Tame grass includes seeded or introduced upland grasses and right-of-way grasses

[4]Other includes brush cover and developed sites.

[5]Unimproved includes all native vegetation less wetlands.

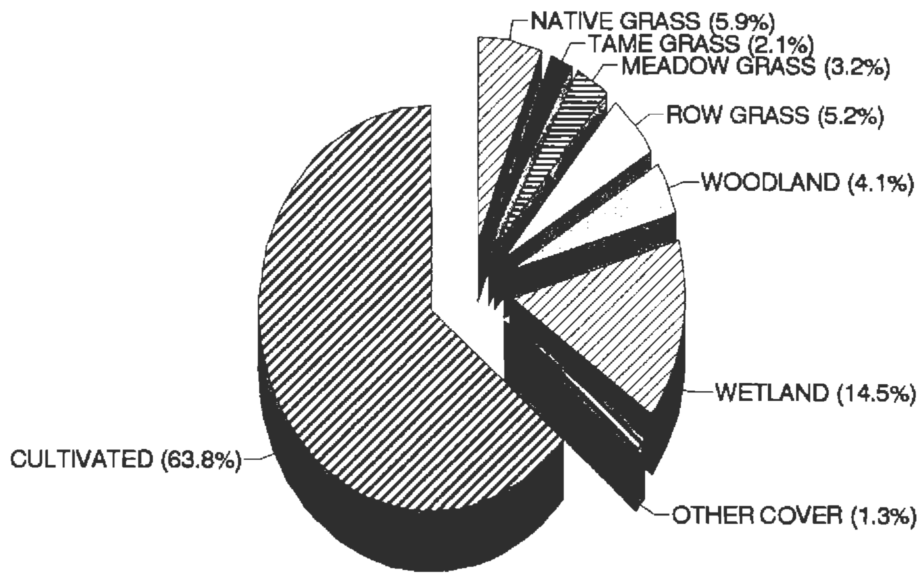

Figure 2. Composition of land cover classes in Antler Municipality, 1987.

Baseline Land Cover Distribution

In the experimental area (1987), total hectares of grassland excluding rights-of-way was 635.4, representing 11.2% of the landscape. In the control area, grassland occupied 424 ha, or 16.4% of the landscape (Figure 2 and 3). The control area contains higher proportions of native, tame, and margin grass. These differences between areas are reflected in relatively more units of pasture land sampled in the control area.

Woodland which includes shelterbelts, but excludes tall shrubs or brush, comprises 4.1% of the experimental area and 7.1% of the control area (Figure 2 and 3). These area differences in the amount of woodland were not significantly different ($p > 0.1$). This represents total wooded areas of 234 ha and 183 ha respectively, as proportionately more transect segments containing larger blocks of woodland (> 4 ha) were found on the control area in association with pasture or idled land.

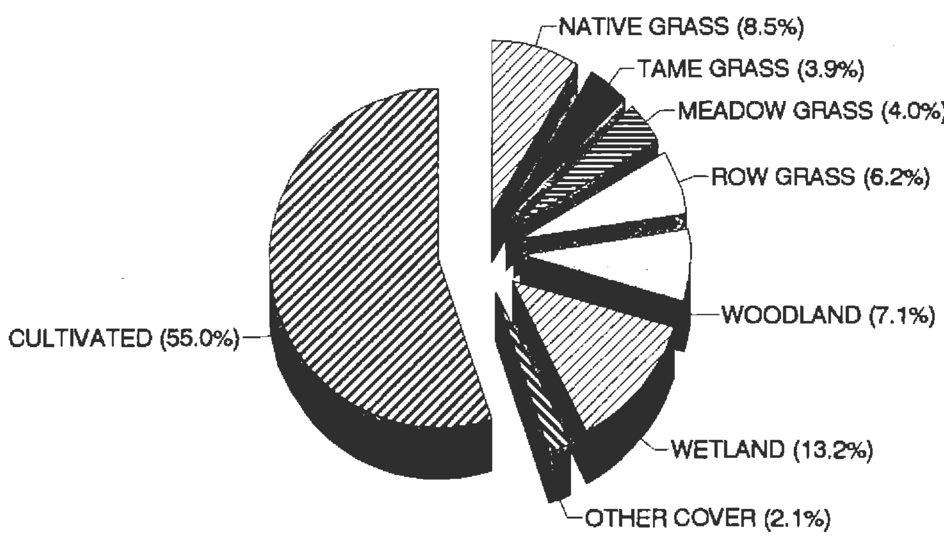

Figure 3. Composition of land cover classes in Walpole and Maryfield Municipalities, 1987.

Table 2. Changes in diversity of cover class units, 1987 to 1990.

		Mean cover patch size (ha)			Density (units/km^2)		
Study area	Cover Class	1987	1990	% change	1987	1990	% change
Experimental	Upland grass	0.83	0.91	+9.6	9.6	8.9	-7.3
	Margin grass	0.31	0.27	-12.9	10.2	5.9	-42.2
	Total grass[1]	0.56	0.65	+19.6	19.8	14.8	-25.2
	Woodland	0.21	0.33	+57.1	19.6	10.4	-53.0
	Wetland	0.17	0.14	-17.6	84.8	83.6	-1.4
Control	Upland grass	0.88	1.07	+21.6	14.1	12.2	-13.4
	Margin grass	0.32	0.39	+21.9	12.5	8.0	-36.6
	Total grass[1]	0.61	0.80	+31.1	26.6	20.2	-24.3
	Woodland	0.27	0.36	+33.3	26.3	17.1	-65.1
	Wetland	0.13	0.10	+23.1	98.0	96.4	-1.6

[1] Total grass excludes right-of-way grass.

Wetlands are a major component of existing native habitat on farmlands of the RM of Antler, Walpole, and Maryfield. In spite of agricultural encroachments, wetlands occupied 825 ha (14.5%) and 341 ha (13.2%) of the experimental and control area transects in 1987 (Figure 2 and 3). The average sizes of wetlands were 0.17 and 0.13 ha (Table 2), with more than 75% of wetlands smaller than 0.2 ha. In 1987, on the experimental area, 6% of the wetland basins and 75% of the wetland margins were cultivated. In addition, combined land use practices, such as cultivation, clearing, and filling, affected 26% of the wetland basins, and impacted the margins of 79% of the wetlands (Adams et al. 1992).

The remainder of the landscape was comprised of right-of-way vegetation which is not likely to be altered by land use practices, cultivated land, and other cover which was comprised of brush, farm yards, and disturbed sites (Figure 2 and 3).

LAND COVER CHANGE 1987-1990

Land use activities, in concert with drought through 1988 and 1989, exerted considerable impact on land cover change in the experimental area by 1990 (Figure 4). A 4.3% increase in the area cultivated represents a total gain on the sampled area of 155 ha. Much of this gain may have been contributed by agricultural encroachment into dry wetlands, as wetlands decreased in mean size from .17 to .14 ha (Table 2) and accumulated area declined by 178 ha (-21.7%). By the spring of 1989, 68% of the wetlands were affected by combined agricultural activities and 43% of the wetland basins and 83% of margins were totally or partially cultivated (Adams et al. 1992). During 1981 to 1985, Turner et al. (1987) documented average incidences of 59% of basins and 78% of wetland margins affected by agricultural practices on waterfowl survey transects in southern Saskatchewan. Corresponding declines of 50.5% occurred in area of marginal grasslands resulting in a net loss of 91 ha. Areas of upland grass (combined native and tame) showed a net increase of 6.5 ha, chiefly due to gains of reseeded pasture or forage, although numbers of grassland patches actually decreased (Table 2). Woodland areas decreased by 38 ha. Therefore, native vegetation cover comprised of grass margins and woodland showed a minimum net loss of approximately 129 ha on the study area transects.

On the control area, land cover changes affected by land use practices were not quite as extensive as on the experimental area (Figure 5). The amount of cultivated land increased by 3.7% or 52 ha. Wetlands showed a similar proportional loss in total area (84 ha) due to agricultural impacts and to reductions in mean size (Table 2) caused by water level declines. Reductions in area of grass margins at 23% were not as

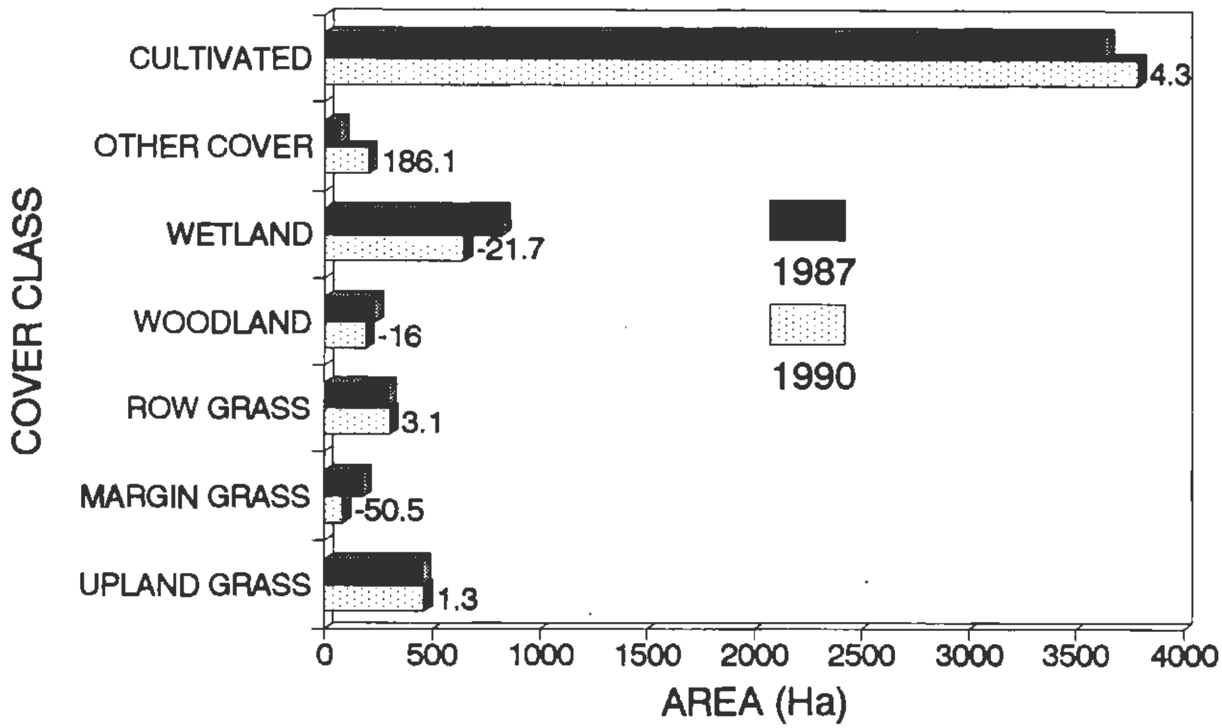

Figure 4. Changes in area of land cover classes in Antler Municipality, 1987 and 1990.

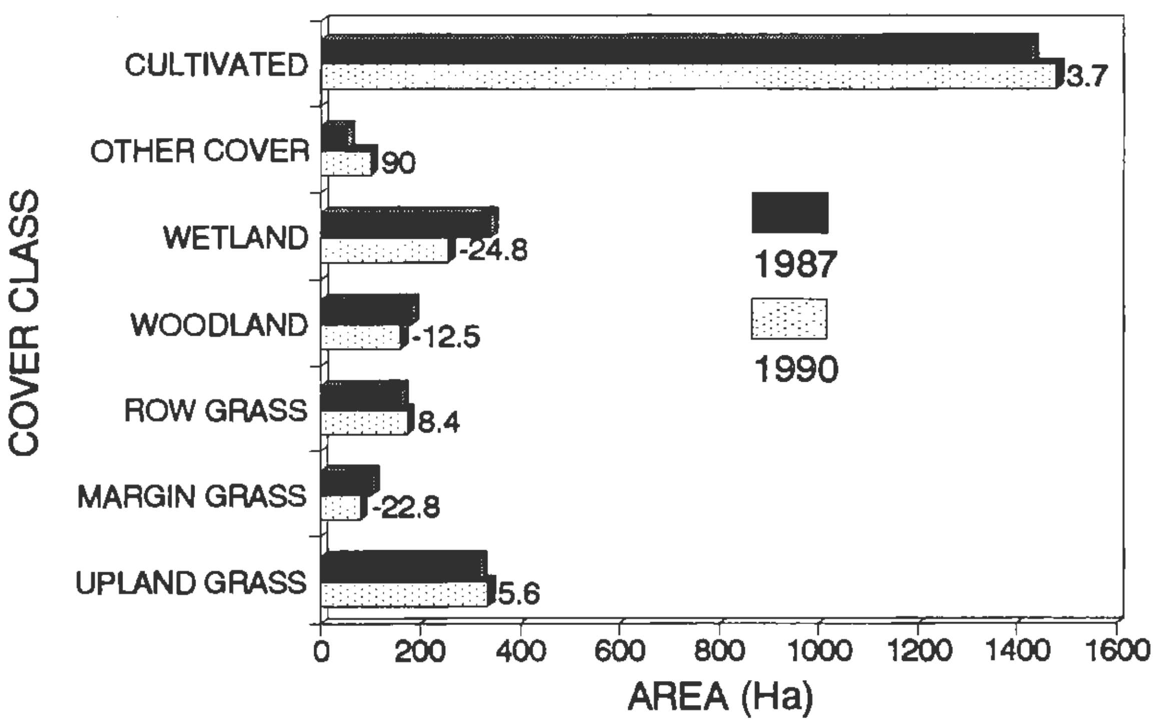

Figure 5. Changes in area of land cover classes in Walpole and Maryfield Municipalities, 1987 and 1990.

extensive as on the experimental area, as shown by the loss of only 24 ha. However, upland grass increased by 17.8 ha or 5.6%, and woodland decreased by 23 ha or 12.5%. In contrast to the RM of Antler, these trends indicate that land use on the control area is more diversified as reflected in increased forage land.

Cover Patch Diversity

Dynamic annual shifts in area of cover classes can occur due to land use-weather interactions, or to conversion of one class to another by clearing, cultivating, or reseeding. As a result, net changes in areas of grassland classes may be masked by gains and losses. Assessment of diversity is another method of determining changes in habitat by means of measuring fragmentation of cover due to land use impacts. Diversity is expressed herein as the distribution and mean size of cover classes, or cover patch units per km^2 (Table 2).

Mean cover patch units on uplands were usually less than 1.0 ha, but patch size appeared to increase slightly between 1987 and 1990 on both study areas. These shifts in mean size were probably related to the destruction of more of the smaller units as total grass units decreased by 24 or 25%. On both areas the grass margin was the grassland class most severely reduced by 1990. Similarly, woodland patches also increased in mean size but densities showed substantial decreases, indicating that clearing impacts were more extensive on the control area which supported the greatest area of woodland. Therefore, diversity of upland cover is highest on the control area, although habitat diversity is deteriorating on both study areas. What may be important is that the rate of change for upland grass on the control area is almost double the rate on the experimental area.

Wetlands that were the most frequently occurring and had the most diverse cover patches on the study areas, were more numerous on the control area. Although modified by land use, few wetlands were totally eradicated. Decreases in mean size from 1987 to 1990 reflected drawdowns in water levels from once flooded basins to recessional shorelines, and consolidation into smaller units. The vegetated borders of wetlands including wet meadows and grass margins gradually adjusted during the interval or were decimated by farming practices.

Cover Conversions in the Antler Municipality

The short-term effectiveness of the Prairie Pothole Project to restore or protect native habitat can be evaluated by comparing the amount of agricultural conversion to the amount of habitat restored, or protected, in the municipality during tbe 1986 to 1990 interval. Estimates of the total amount of grassland on private lands in the municipality were derived from prorating grassland hectares on the transect area to the entire study area after deducting 2850 ha of unimproved Crown land. In 1990, the total estimated grassland, excluding rights-of-way, in the municipality was 7560 ha. During the 1987 to 1990 interval, net losses of grassland were projected to be approximately 1170 ha. Counteracting these losses were the protection by lease or easements of 623 ha of idled pasture and the conversion of 202 ha of cropland to seeded grassland (SNR). Following losses of about 566 ha, the remaining woodland present in 1990 occupied about 2750 ha. However, blocks of woodland comprise most of the 2850 ha of Crown lands, part of which is designated "critical wildlife habitat." Except for Crown lands which occupy only 3.5%, the extent of existing native habitat and grasslands within the municipality of Antler is under threat to agricultural conversion, in spite of efforts through habitat restoration programs to reverse this trend.

Rates of loss of parkland habitat are high and are continuing in the municipality, although extensive habitat retention programs have preserved some patches of prairie and parkland. The extent of fragmentation of parkland habitat as discussed by Rowe (1987), is probably more serious in southeastern Saskatchewan in the 1990s as indicated by the low percent coverage (3.4 to 6.2%) and substantial reductions in patches of woodland (Table 2). Small habitat complexes which include tracts of grassland and woodland filling interstitial spaces among associated wetlands, are disappearing due to agricultural conversions. These losses reduce biodiversity by affecting habitat utilized by waterfowl, upland game birds, passerine birds, and White-tailed Deer (*Odocoileus virginianus*). It is uncertain whether habitat enhancement programs aimed at restoring waterfowl nesting habitat will be able to protect the remaining parkland ecosystems in heavily farmed regions.

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LITERATURE CITED

Adams, G.D., A.B. Didiuk, D. Pochailo, and K. Eskowich. 1992. Impact of drought and land use on prairie potholes in the Antler municipality, Saskatchewan. *In*: Aquatic Ecosystems in Semi-Arid Regions: Implications for Resource Management (R.D. Robarts and M.L. Bothwell, eds.). N.H.R.I. Symposium Series 7, Environment Canada, Saskatoon, Saskatchewan.

Anderson, D.W., and J.G. Ellis. 1978. Soils of the Weyburn-Virden map area. Saskatchewan Institute of Pedology, Saskatoon.

Millar, J.B. 1988. Baseline (1985) habitat estimates for the settled portions of the prairie provinces. Report No. 2, Saskatchewan Parkland, Part 1. Prairie Habitat Monitoring Project, Canadian Wildlife Service, Saskatoon, Saskatchewan. 44 pp.

Rowe, J.S. 1987. Status of the aspen parkland in the prairie provinces. Pp. 27-33 *In:* Endangered species in the prairie provinces (G.L. Holroyd, P.H.R. Stepney, G.C. Trottier, W.B. McGillivray, D.M. Ealey, K.E. Eberhart eds.). Natural History Occasional Paper 9. Provincial Museum of Alberta, Edmonton, Alberta.

Saskatchewan Natural Resources. 1987. Prairie Pothole Project, Phase 2. Progress Report 87-2, Wildlife Branch. 25 pp.

Statistics Canada. 1987. Census Canada 1986, Agriculture. Minister of Supply and Services.

Stoudt, J.H. 1971. Ecological factors affecting waterfowl production in the Saskatchewan parklands. Resource Publication 99. Bureau of Sport Fisheries and Wildlife, U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C. 58 pp.

Turner, B.C., G.S. Hochbaum, F.D. Caswell, and D.J. Nieman. 1987. Agricultural impacts on wetland habitats on the Canadian prairies, 1981-1985. Pp.206-215 *In:* Transactions 52nd North American Wildlife and Natural Resources Conference.

United States Fish and Wildlife Service and Canadian Wildlife Service. 1987. Standard operating procedures for aerial waterfowl breeding ground population and habitat surveys. U.S. Department of Interior and Environment Canada.

MONITORING NATIVE PRAIRIE - SESSION DISCUSSION

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On the utility of satellite data, J. Polson suggested that different user groups should be more interested in getting together to share costs, data needs, and information. Also, the accessibility to the computer part of the system is not easy. Training of technicians in analyses procedures will improve access. LANDSAT imagery is not affordable for a small user. LANDSAT methodology is more cost effective and more feasible for interagency use, especially as a mapping tool. Intensive survey programs are not working. What other options do we have?

Should we focus efforts on saving marginal lands or good quality grasslands? Over the years (via man or grazing), we have lost tremendous diversity in our native plant areas. Perhaps there are very few areas, if any, which we can class as being truly native. We need to identify tracts of prairie vegetation and determine composition of native plants. Should we preserve and manage already modified grasslands? There are not many native grassland areas remaining, especially in the sand hills.

How long does it take to restore prairie habitat? At Manyberries, at least 55 years was required to restore biological diversity on heavily grazed mixed grass prairie. Some areas may never be restored to pristine conditions. It is doubtful that we could ever restore very rare plant species.

Steps to identify and manage existing native grasslands. We should start monitoring not only the quantity but the quality of remaining grasslands. Government agencies should continue to be involved, but a participatory framework is needed to involve the farmer/rancher who owns or manages the land. Indicator plant species should be selected and monitored for native prairie types on localized landscapes. Management of existing prairie should involve controlled burns.

Steps to preserve prairie habitat. Local people need to be involved in stewardship of prairie. Through fostering pride of ownership of prairie, local people develop a stake in prairie conservation. How do we get people involved? Local landowners lack expertise iu managing grasslands; therefore an educational program is necessary. We must change attitudes of people toward land, and promote awareness of why society should retain native species. Conservationists have to learn to understand agricultural people. Various financial incentive programs need to be developed to interest landowners. Perhaps we should look at options such as the American "Sodbuster Law." We must also change environmentally negative agricultural policies and programs such as Gross Revenue Insurance Programs and Net Income Stabilization Acconnt that are based upon acreage quotas.

Land use impacts on habitat. Assuming we return to the "good water years" of the late 1940s and early 1950s, what percent of impacted sloughs/wetlands would be lost permanently? This is difficult to say, but up to 40% of wetlands may have been lost in some regions. Other impacted wetlands would require more than two years of flooding to restore dominant native plant species.

Are we changing the evolutionary process? Is conservation of ecosystems interfering with a natural process which leads to evolutionary extinction of species?

MILITARY TRAINING AND CONSERVATION ON CANADIAN FORCES BASE SHILO, MANITOBA

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Canadian Forces Base (CFB) Shilo is located 25 km east of Brandon in southwestern Manitoba. Bounded on the south by the Assiniboine River and on the east by Spruce Woods Provincial Park, Shilo encompasses some 39,000 ha, primarily provincial Crown land. The military base, and the provincial park, both lie in a physiographic area known as the Upper Assiniboine Delta. Characterized by lacustrine or aeolian deposits of sand, formed from the Assiniboine River discharging into glacial Lake Agassiz some 12,000 years ago, the landscape at Shilo encompasses open unstabilized sand dunes, stabilized dunes with a combination of aspen parkland and prairie vegetation, and flat open areas of mixed grass prairie.

In the early 1900s, the Department of National Defense (DND) began training at Shilo and has used the area ever since. Primarily a training base for artillery and infantry troops, Shilo was relatively unaffected by military training activity for many years. In 1973, however, a North Atlantic Treaty Organization (NATO) agreement between Canada and the Federal Republic of Germany permitted both mobile artillery and tank training on Shilo during the summer and early fall of each year. This consistent use, in addition to training by Canadian Forces and militia, is more intensive than since the period during World War II.

As a result of the 1973 agreement with Germany, a new federal-provincial lease agreement was signed, and subsequently renewed in 1983, which stipulated (among several conditions) that DND: 1) conducts an ongoing program of decontamination of explosives; 2) maintains a program of fire prevention, detection, and suppression; 3) restricts military use and vehicular traffic in the Bald Head Hills and Epinette Creek, areas that are ecologically sensitive or difficult to access.

The Department of Natural Resources (DNR), the provincial department responsible for Crowu land administration: 1) reserved the right to provide wildlife use programs (primarily hunting seasons) in accordance with safe periods on the training area; 2) reserved the right to permit timber cutting in selected areas; and 3) reserved the right to issue annual hay or grazing permits on Crown land not used by DND.

The agreement also calls for joint cooperation and participation on the Shilo Environmental Advisory Committee (SEAC), established to advise the Commander of CFB Shilo and the Minister of DNR on environmental and resource issues and concerns. The committee is composed of biologists, botanists, resource planners, and military staff from federal and provincial agencies as well as the University of Manitoba and the Manitoba Museum of Man and Nature.

SEAC meets two or more times each year to review program proposals and changes in military training plans. The Base Commander has often requested specific advice on the potential impact to the environment of proposed changes in the military training program or related activities. Although there is frequent turnover in the military staff representatives to SEAC, the majority of representatives from other agencies has remained consistent since the committee was established. This continuity has enhanced the ability of SEAC to function as originally proposed. To further clarify the role of SEAC, Terms of Reference were signed by the Base Commander and Minister of DNR in 1990.

Background information and detailed biological and botanical data for the wildlife species and different eco-types present on Shilo was scarce or nonexistent at the time SEAC was formed. When advice was sought by military staff, the SEAC members could only recommend that biological studies be carried out as a means of providing sound answers. The initial lease agreement did not assign responsibility for financial support for such studies which were necessary if SEAC was to provide recommendations and advice to the Base Commander and the Minister of DNR.

As the need for specific studies were identified, cooperation of a number of agencies has enabled completion of a broad spectrum of studies. Through the contribution of direct funding, staff, facilities, and equipment, the governments of West Germany, Canada (through DND), and Manitoba, the World Wildlife

Fund (Canada), the University of Manitoba, and the Museum of Man and Nature, have enabled research and management efforts to be completed.

Wildlife studies or management efforts have been completed on Elk (*Cervus elaphus*), the little known Western Hognose Snake (*Heterodon nasicus*), Northern Prairie Skink (*Eumeces s. septentrionalis*), Sharp-tailed Grouse (*Tympanuchus phasianellus*), Swift Fox (*Vulpes velox*); population inventories and distribution studies of Moose (*Alces alces*), Elk and White-tailed Deer (*Odocoileus virginianus*), and nongame bird population inventories.

Ecological studies have focused on: 1) the distribution and frequency of Leafy Spurge (*Euphorbia esula*); 2) the effects of fire on native plant communities; 3) the effects of fire on the abundance of undesirable non-native plants; 4) the effects of tank traffic on plant cover and soil compaction; 5) the relationship between soil disturbance and Leafy Spurge abundance; 6) the identification of principal vegetation types within the Shilo military reserve; 7) the vegetative changes on Shilo for the period covered by the NATO agreement; and 8) reclamation measures for the revegetation of damaged tank battleruns.

Canadian military training is largely restricted to the use of artillery, most of which takes place from fixed locations on the western and northern fringes of the training ranges. Impact areas are in the central portion of the base which has rough topography and forest, or tree/shrub cover. Infantry training takes place throughout the base, primarily using wheeled vehicles but with some tracked armoured personnel carriers.

German military training, for the most part, has been confined to several flat or undulating mixed grass prairie areas on the western and southern limits of the ranges. German training is centred around the use of the Leopard Tank and the Marder; both heavy tracked vehicles. To date, the method of tank training has been restricted to straight line shooting at targets spread along the length of the open prairie "battleruns." These areas were deemed to have the greatest trafficability as well as the open expanses needed at the onset of German training in 1974.

German forces have been extremely cooperative in adhering to a caution against power turns while maneuvering along the length and breadth of the individual battleruns, thus minimizing or preventing vegetation and soil disturbance, and subsequent wind erosion. Unfortunately, the necessity of intensive training required for several thousand troops each summer, and the relatively narrow width of each battlerun has left little opportunity to avoid use of a portion of each battlerun as has been suggested. For many years, the principal battleruns were the only prairie areas affected. Several areas on the western and southern periphery of the base, also native prairie, received little, if any tracked vehicle traffic.

In recent years, however, changes in economic conditions and military strategy in Germany have dictated changes in training at Shilo. The majority of fires on Shilo during the training season are caused by tank ammunition. A decrease in the amount of live firing should decrease the fire frequency on the native prairie and on the adjacent aspen/shrub landscape. This reduction in the amount of live firing tank training has led to the desire to use more of the "dry-training" native prairie areas on the base periphery.

It is the latter activity, coupled with the wish to undertake more tactical type of dry training with tracked vehicles in other areas of rougher terrain, that has led DND to recently conduct an environmental evaluation of Germany's proposal. The results of this evaluation have not yet been completed, nor have any final decisions been made as to future German usage of areas other than the traditional battleruns.

When military training on CFB Shilo intensified dramatically in the early 1970s, there was mutual concern by military staff, natural resource and environmental managers, ecologists, and the public on the potential affects of increased training activities on the wildlife, and the unique sandhill and prairie landscape of Shilo. It would be foolish to suggest that there have been no changes and no impacts, because there have. It is understood that DND has a mandate, and Canada has had a commitment to its NATO allies, to train troops within limits set by economics, military strategy, and political changes on a national and global scale. The economy of southwestern Manitoba has benefitted substantially from a military presence and the agreements still in place. All of these factors come to bear on how CFB Shilo has been used and will continue to be used in future.

To date, the cooperation between DND, DNR, other federal and provincial agencies, and the SEAC has been substantial. There have been periods, or instances of disagreement or difficulty, but after almost two decades of intensive military training by Canadian and German forces, many of the initial fears have been allayed. A substantial body of information now exists upon which to formulate recommendations and cooperation continues between the agencies involved. As an advisory body, the SEAC can only provide the best recommendations possible on use of this fragile prairie ecosystem; it can advise and educate, but not legislate, on the ultimate use of any portion of Shilo. The maintenance of this ecosystem, and its valuable floral and faunal constituents, will be a challenge to those faced with the responsibility of making decisions while striving to accommodate the realities of military training and the need for prairie conservation.

THE LAST MOUNTAIN LAKE NATIONAL WILDLIFE AREA - PAST, PRESENT AND FUTURE

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INTRODUCTION

Best known for its spectacular concentrations of hundreds of thousands of fall migrant birds, particularly waterfowl and Sandhill Cranes (*Grus canadensis*), the Last Mountain Lake National Wildlife Area (NWA) also supports a host of other species of prairie wildlife. Home of the first bird sanctuary in North America (established in 1887), the area has a fascinating history spanning over 100 years. This talk will explore the past, present, and future conservation issues at Last Mountain Lake which affect this unique area as well as many other prairie sites.

THE PAST - A HISTORICAL REVIEW

In the years before 1887, the grassland and wetland habitats at the north end of Last Mountain Lake supported a rich variety of prairie wildlife. For hundreds of years aboriginal peoples made a living off these resources. In 1690, European exploration entered the region followed by fur traders in search of beaver and other wildlife to satisfy the fashion trends of the period. Fur trading at posts like Last Mountain House was at its peak from the late 1700s to the late 1800s across the prairies (Hendry 1987). In July 1869, Isaac Cowie, a clerk with the Hudson's Bay Company, passed through one of the last great herds of American Bison (*Bison bison*) at the north end of Last Mountain Lake. He (1913, page 373) wrote: "They blackened the whole country, the compact moving mass covered it so that not a glimpse of green grass could be seen. Our route took us into the midst of the herd, which opened in front and closed behind the train of carts like water round a ship.... So we travelled among the multitudes for several days." In 1879 John A. Macoun (1882), the botanist, wrote of the north end of Last Mountain Lake: "Multitudes of pelican, geese, ducks, avocets, phalaropes, waterhens, and grebe, besides innumerable snipe and plover were everywhere, in the marshes at the head of the lake or along its shores, or on small islands lying to the south of the camp. This was early in July and experience tells me that not one tenth was then seen of the bird life assembled in September and October." The wildlife of the prairies seemed limitless.

But the winds of change had already arrived (Foster 1978, Hewitt 1921). By 1879 the great herds of Bison were gone and by 1884 only scattered animals remained; the last wild Bison in prairie Canada apparently being shot before 1890. By 1880, Eskimo Curlew (*Numenius borealis*), Hudsonian Godwits (*Limosa haemastica*,) and Lesser Golden-plover (*Pluvialis dominica*) populations had crashed. By 1900 the Labrador Duck (*Camptorhynchus labradorius*), Great Auk (*Pinguinus impennis*), and Passenger Pigeon (*Ectopistes migratorius*) were all but extinct and many other species were becoming rare including Whooping Crane (*Grus americana*), Trumpeter Swans (*Cygnus buccinator*), Wood Ducks (*Aix sponsa*), and Great Egrets (*Casmerodius albus*). Many factors were the cause of these declines including market hunting and the plume trade supplying colourful bird feathers for milliners to make fashionable hats (Foster 1978). In this climate North Americans began to be concerned with broad conservation issues.

A letter written in March 1887 by the Lieutenant Governor of the North-West Territory, Edgar Dewdney, to the Minister of the Interior, Thomas White, in Ottawa concerning Last Mountain Lake perhaps constitutes Canada's first environmental impact assessment (Public Archives of Canada and Canadian Wildlife Service [CWS] historic files). Concern over construction of the railroad into the district and the accompanying settlement caused Dewdney to recommend reserving the islands near the north end of the lake for "these islands are the favorite breeding grounds for almost all the different varieties of wildfowl we have in the North-West, from pelicans to snipe.... The shores of the islands are literally covered with eggs in the breeding season" (ibid.). With considerable foresight, on June 8, 1887 Sir John A. MacDonald and his government set aside some 1025 ha of land including islands, peninsulas, and shores as "breeding grounds for wildfowl" (ibid.).

The reservation of additional lands for federal bird sanctuaries in the prairies did not take place until later (1911 to 1915): 12 lakes in Saskatchewan (including Quill, Lenore, Redberry, and Old Wives lakes), 14 in Alberta (including Pakowki, Miquelon, Ministik, and Many Island lakes), and none in Manitoba. With the signing of the historic treaty for the protection of migratory birds between Canada and the United States in 1916 and passage of the Migratory Birds Convention Act (MBCA) in 1917 over 400 species of birds were protected. In 1917 and 1918, R.M. Anderson reviewed these prairie lakes for the federal Advisory Board in Wild Life Protection and reported on their suitability as sanctuaries. Sanctuary status was afforded 7 lakes in Alberta in 1920 and 12 lakes in Saskatchewan in 1925, including surrounding uplands. In 1925, additional lakes in Alberta, Saskatchewan, and Manitoba were reserved as Public Shooting Grounds to compliment the sanctuaries, protect more habitat and "to foster a spirit of sportsmanship" by discouraging excessive hunting. It was the first comprehensive system of wetland and wildlife stewardship in the prairies (Hewitt 1921).

The severe drought of the 1930s began to unravel these landmark conservation efforts. Pressure from the agricultural community was extreme. In 1951, the Public Shooting Grounds were abolished. Between 1946 and 1956 several sanctuaries were delisted and replaced by smaller ones. But the most devastating blow was the loss of nearly all upland habitat around the sanctuaries. Some 66,000 acres of sanctuary land in Saskatchewan was reduced to less than 4000 acres. Only at Last Mountain Lake was the upland retained relatively intact (Murry 1966, Taylor and Jorgenson 1985).

In the 1960s, the CWS began to acquire migratory bird and wildlife habitat for permanent protection at Last Mountain Lake and other sites across Canada. The Canada Wildlife Act (CWA) (1973) enables the CWS to manage these areas as NWAs using stronger, yet more flexible, habitat and wildlife conservation regulations than afforded the sanctuaries under the MBCA (1917). Today, across Canada there are approximately 100 Migratory Bird Sanctuaries and 50 NWAs totalling over 113,000 km^2, with more being added each year. The sanctuaries and NWAs comprise the lands protected and administered by CWS, for wildlife conservation purposes.

The year 1987, the centennial of the Last Mountain Lake Bird Sanctuary, afforded Canadians the opportunity to rededicate themselves to conservation of wildlife and their habitats. With tremendous public and nongovernment support, "Wildlife '87: Gaining Momentum" became a reality. On June 5, 1987 His Royal Highness, Prince Philip witnessed the signing of an agreement between the Governments of Saskatchewan and Canada to assign the lands at the north end of Last Mountain Lake for a NWA (Taylor 1987). Since that date, the titles to provincial lands have been transferred to Canada and our federal Department of Environment is in the final stages of legally declaring the site as a NWA.

THE PRESENT - CONSERVATION PLAN AND PROGRAMS

To address the many challenges facing the Last Mountain Lake NWA, the CWS is developing a Resource Conservation Plan (RCP) which will guide the NWA into the 21st Century. An opportunity for public review and comment on the plan will be offered to interested groups and individuals later in 1992. Guiding the plan's preparation are the Terms of the Agreement with Saskatchewan, the CWA, several international agreements for the protection of migratory bird habitats, and our on site management experience over the past 25 years.

The primary purpose of the Last Mountain Lake NWA is to protect and enhance the variety of habitats for wildlife. It is the underlying policy which guides all management programs and activities on the area. The RCP addresses four main management topics: upland habitat conservation; wetland habitat conservation; wildlife conservation; public use and information.

Upland Habitat Conservation

These management programs focus on the protection and enhancement of native habitats. Mixed grass prairie and western snowberry shrub communities typically dominate uplands with higher sites supporting fescue grassland species and lower sites supporting saline tolerant species.

One of the most effective management tools in native grass management and enhancement is fire. Prescribed burning can be used to simply reduce fuel loads and litter build up on an area; to control the spread of exotic and undesirable plant species; to encourage seed production; and to alter plant succession.

We have used fire on the NWA as a management tool for over 10 years. A five-year research project by E.A. Driver (CWS, Saskatoon) monitored the effects of fire on plants, birds, and small mammals and will serve to guide our use of fire. Fire benefits many wildlife species including Baird's Sparrow (*Ammodramus bairdii*), Sharp-tailed Grouse (*Tympanuchus phasianellus*), Burrowing Owl (*Athene cunicularia*), shorebirds, and waterfowl by improving nesting cover and food availability (Driver 1987). The results of this work are being applied across the prairies at places like the Living Prairie Museum in Winnipeg, the Grasslands National Park, and the Fescue Prairie in Saskatoon.

Upland sites which have suffered degradation on alteration on the NWA are candidates for restoration. Dean Nernberg (1991) a graduate student at the University of Alberta undertook an inventory of the grassland communities on the NWA, studied germination and growth rates for grasses to be used in reseeding and prepared a "restoration manual" to guide the work at Last Mountain Lake.

Studies into the relationships between agriculture and wildlife have been of special interest at Last Mountain Lake for over 25 years and have included research on crop damage, rest rotation grazing, and deferred hay cutting (CWS Saskatoon, unpublished). Brenda Dale's work on hay cutting is a part of one of the special sessions of this workshop. Grazing and haying when applied carefully can be used as wildlife management tools for the mutual benefit of wildlife and man.

Wetland Habitat Conservation

These management programs focus on maintaining the wide variety of wetland habitats represented at Last Mountain Lake: from deep lake and marsh waters to shallow flooded meadows; from freshwater springs and fens to saline shorelines and basins.

Within the NWA, several basins have controlled water levels to simulate natural water fluctuations which have occurred on the area in the past. Water control projects upstream and downstream (Last Mountain Lake proper) have reduced the natural cycles of flooding and drying on the area. Through the joint efforts of CWS, Ducks Unlimited (DU), and the North American Waterfowl Management Plan (NAWMP), the wetland management program on the area is being improved steadily. An effort has been made to provide examples of most of the basic wetland management techniques used across the prairies at Last Mountain Lake: construction of dams, dykes, and related water control structures; construction and blasting of small wetlands; placement of artificial nesting structures; building nesting islands; level ditch excavations; and water manipulation through the use of pumps and natural water flows.

Wildlife Conservation

These programs focus on maintaining a diversity of prairie wildlife while ensuring that endemic, often rare, species, which have specific habitat requirements, are protected.

The north end of Last Mountain Lake is a major staging area for hundreds of thousands of water birds. Up to 400,000 geese of four species, uncounted ducks, and 50,000 Sandhill Cranes have been recorded using the area at one time. The area is particularly important during drought years. Some 270 species of birds have been recorded for the area with over 100 of these staying to breed (Dale 1987).

Besides its values as a migration stopover and breeding area, Last Mountain Lake provides appropriate habitat for nine of Canada's 31 species of vulnerable, threatened, or endangered birds as classified by COSEWIC (Committee on the Status of Endangered Wildlife in Canada). The species include Peregrine Falcon (*Falco peregrinus*), Piping Plover (*Charadrius melodus*), Whooping Crane, Burrowing Owl, Ferruginous Hawk (*Buteo regalis*), Loggerhead Shrike (*Lanius ludovicianus*), Cooper's Hawk (*Accipiter cooperii*), Baird's Sparrow, and Caspian Tern (*Sterna caspia*). Most notable are the high breeding populations of Loggerhead Shrikes and Baird's Sparrows on and around the NWA. Both prefer taller, less disturbed grasslands.

A wide variety of monitoring and research projects have been done on birds at Last Mountain Lake. These include broad ecological studies on waterfowl nesting, staging and feeding; grassland passerines, breeding and staging; shorebirds and sensitive colonial birds; and single species studies like the Sandhill Crane, Loggerhead Shrike, Sharp-tailed Grouse, and Wilson's Phalarope (*Phalaropus tricolor*). Major long-term banding programs are underway on waterfowl (prairie nesting ducks) and migrant passerines. The latter known as the Last Mountain Banding Station will as one of its aims monitor changes in populations of neotropical migrants.

Less well-known are the 33 mammal species (Jorgenson 1987) and six herptile species recorded for the area. A preliminary listing of plants found on the area totalled over 300 species of which seven are considered rare in Canada (Caldwell et al. 1987). Species of concern include mustelids like the Long-tailed Weasel (*Mustela frenata*), the Leopard Frog (*Rana pipiens*), Upland White Goldenrod (*Solidago ptarmicoides*), and Golden Currant (*Ribes aureum*).

Public Use and Information

These programs encourage people to visit the area at times and in ways which can be sustained over time. Most public uses are limited to portions of the NWA at any given time.

The NWA is open to the public during daylight hours. Strictly regulated, hunting, sport fishing, boating, and vehicle use are permitted on portions of the area. Non-consumptive uses such as photography, hiking, and nature observation are encouraged. The public information program presently consists of an information kiosk (with displays, brochures, and guest registration), a 14 km self-guided driving tour, wetland nature trail, grassland nature trail, observation tower, and information signs. The public are also invited to participate in the banding station activities at the Last Mountain Regional Park.

These information programs focus on wildlife management programs and ecological relationships found at Last Mountain Lake plus national and international conservation programs linked to the area: International Biological Program Site status (1970); Ramsar Wetland Status (1982); National Historic Site (1990); Western Hemisphere Shorebird Reserve Network Candidate Site.

THE FUTURE

Last Mountain Lake is one of the lucky places where its biological values have been recognized for a long time and concrete efforts to protect the site are in place. However, it serves as an example of how difficult it is to conserve a critical site. Over 120 years have elapsed between Isaac Cowie's experience with an estimated three million Bison at the north end of Last Mountain Lake and its permanent protection as a NWA.

By protecting the diverse habitats and wildlife species using Last Mountain Lake we hope to continue to contribute to the Prairie Conservation Action Plan (PCAP) (World Wildlife Fund [WWF] 1988). The RCP for the NWA has incorporated many of the concepts promoted under the PCAP.

We will continue to rely on partnerships in conserving Last Mountain Lake. To date the list of cooperators is lengthy: the Saskatchewan Parks and Renewable Resources, Wildlife Branch, three universities and one technical college, various municipal governments, Wildlife Habitat Canada, DU, the NAWMP partners, the Saskatchewan Natural History Society, the Saskatchewan Wildlife Federation, WWF, and numerous local residents, naturalists, and interested individuals. To them we extend our thanks, and we look forward to the challenges of the next 100 years.

LITERATURE CITED

Caldwell, J.R., P.S. Taylor, E.A. Driver and L.J. Shandruk. 1987. Plants of the Last Mountain Lake National Wildlife Area, Saskatchewan. The Blue Jay 45(4):234-245.

Canadian Wildlife Service. Various unpublished reports and historic files. Saskatoon, Saskatchewan.

Cowie, I. 1913. A company of adventurers. W. Briggs. Toronto.

Dale, B.C. 1987. The birds of Last Mountain Lake and Stalwart National Wildlife Areas, Saskatchewan. The Blue Jay 45(4):246-260.

Driver, E.A. 1987. Fire on grasslands - friend or foe? The Blue Jay 45(4):217-225.

Foster, J. 1978. Working for wildlife: the beginning of preservation in Canada. University of Toronto Press, Toronto.

Hendry, G. 1987. A refuge for wildlife. The Blue Jay 45(4):204-216.

Hewitt, G. 1921. The conservation of wildlife in Canada. Scribners, New York.

Jorgenson, C. 1987. Mammals around the north end of Last Mountain Lake. The Blue Jay 45(4):267-271.

Macoun, J. 1882. Manitoba and the great northwest. Guelph World Publishers.

Murry, L.H. 1966. Bird sanctuaries in Saskatchewan, 1887-1965. The Blue Jay 24(3):110-120.

Nernberg, D. 1991. Species mapping and techniques for restoration of native vegetation; Last Mountain Lake National Wildlife Area. Unpublished Report. Habitat Conservation Section, Canadian Wildlife Service, Saskatoon.

Taylor, P.S. 1987. Wildlife '87: Gaining Momentum. The Blue Jay 45(4):192-195.

Taylor, P.S. and C. Jorgenson. 1985. Sanctuaries in Canada. The Blue Jay 43(2):102-106.

World Wildlife Fund. 1988. Prairie Conservation Action Plan. WWF Canada, Toronto, Ontario.

GRASSLANDS NATIONAL PARK - STATUS OF LAND ACQUISITION AND MANAGEMENT CHALLENGES

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The signing of the Federal/Provincial Agreement on September 23, 1988 to establish Grasslands National Park (GNP) marked the end of years of political wrangling. The signing also marked the conclusion of a very persistent and successful lobbying campaign by conservation groups which began 30 years earlier. The agreement is also significant because it introduced a few new wrinkles in the normal process of establishing national parks.

For the first time water courses would not form part of the proposed national park and administration and control of the lands comprising the water courses will remain with Saskatchewan. It was further agreed that such lands would be managed to compliment national park purposes. The nine streams affected by this clause have been surveyed and legal survey plans are being prepared to delineate the lands involved. The exclusion clause will be re-examined on each 10 year anniversary of the signing of the agreement for the next 30 years.

Another first in the agreement was the requirement by Canada to purchase leasehold and freehold interests directly from current operators and owners. The agreement specifies that Canada shall acquire lands on a willing buyer - willing seller basis and that expropriation shall not be used.

I am happy to report that through this new process the Canadian Parks Service (CPS) has acquired nearly one half of the lands proposed for GNP. To date 31 landowners have requested appraisals, all but one is complete. Negotiations have been held with 29 and 24 signed options received (Table 1).

Table 1. Lands acquired for Grasslands National Park.

	IN	OUT	TOTAL
West Block			
Prior to 1989	49.25	5.25	54.50
Since 1989	43.25	13.50	56.75
*Crown Land	8.00		8.00
Total	100.50	18.75	119.25
East Block			
Since 1989	61.25	25.50	86.75
*Crown Land	7.00		7.00
Total	68.25	25.50	93.75
TOTAL	168.75	44.25	213.00
	79.0%	21.0%	

(area is expressed in sections - sq. mi.)

*Land which is owned by the Crown and will not require purchase

NOTE: Land available for GNP 48%

Figures 1 and 2 display the distribution of acquired lands.

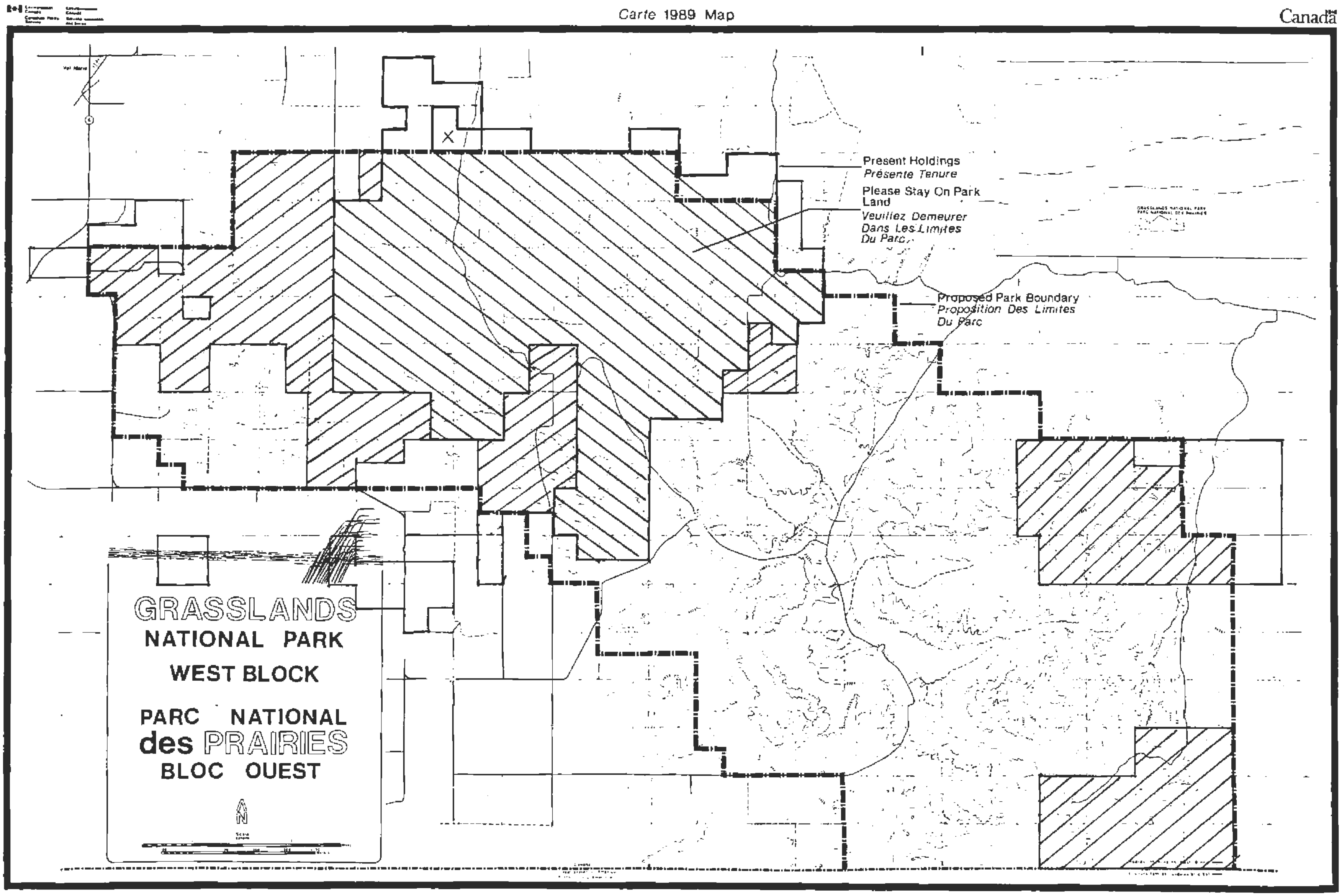

Figure 1. Grasslands National Park, West Block

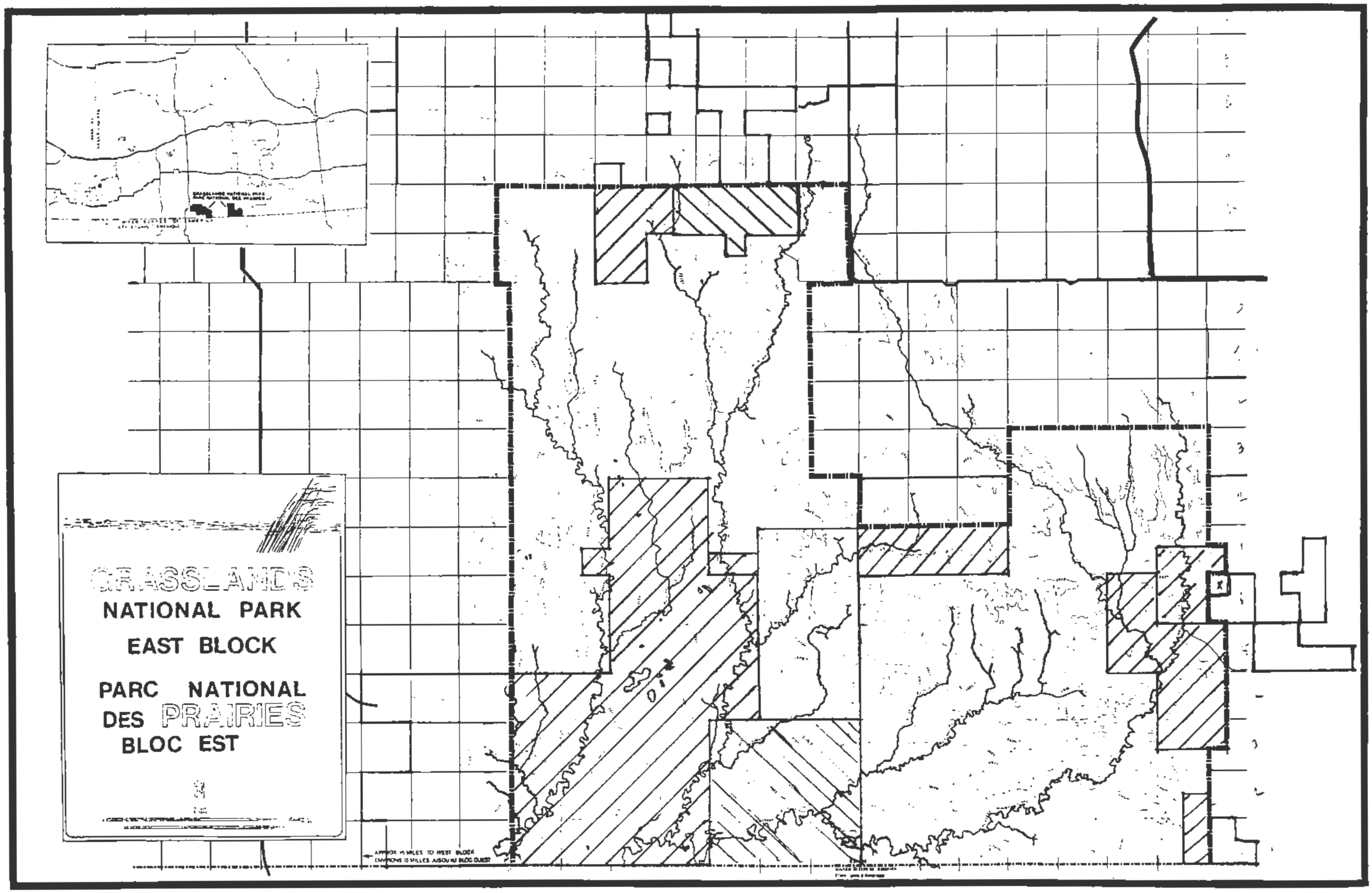

Figure 2. Grasslands National Park, East Block

The 1988 agreement is unique in its provisions for mineral exploration. Exploration permits on lands outside the core area were to be issued in the nine month period following the signing. No permits were applied for; consequently Saskatchewan placed all of the proposed park lands in a mineral reserve on July 21, 1989. No mineral exploration could take place except on lands which were previously encumbered.

Dating back to the Hudson's Bay Company Charter and subsequent agreements, mineral rights to 2077 hectares were held by a group of oil companies. This ownership could frustrate the legal establishment of GNP because mineral rights to all acquired lands could not be transferred to Canada. Through the efforts of the Nature Conservancy of Canada (NCC), AMOCO Canada and partners transferred their interests to NCC on condition that these would be also transferred to Canada. The donation was duly celebrated in Regina on January 13, 1992.

Progress has also been realized in areas of research, planning, and operations. The Interim Management Guidelines which provides guidance to park managers pending the approval of a formal park management plan, has been approved. The formal planning program is scheduled to commence in 1993/1994. A soil survey has been completed by the Saskatchewan Institute of Pedology and their report is due March 1, 1992. Archaeological survey of much of the acquired lands has been conducted for two field seasons. This program will continue as land is acquired and funds permit. Discussions are proceeding with numerous agencies regarding the management and reintroduction of endangered species. Recently released Swift Foxes (*Vulpes velox*) have been spotted in the park and they will hopefully become permanently established. GNP is the prime area for Black-footed Ferret (*Mustela nigripes*) reintroduction in Canada. Discussions between Saskatchewan, CPS, Canadian Wildlife Service, and United States counterparts will determine when a reintroduction will be attempted.

Another significant achievement worth noting is a Service Bureau contract with the University of Regina. Through this arrangement the Department of Geography will input park data into a Geographic Information System program. The increased analytical and presentation capacity should prove very useful in the upcoming planning programs. More importantly, cooperation forges worthwhile links with the university which should prove mutually beneficial in the future.

Obviously the CPS has been able to meet some of its challenges but others remain to be addressed. Initially the most significant challenge was to acquire land and establish a momentum in creating the park. Although this challenge has been significantly accomplished it will be prominent over the next decade. I believe that the remaining properties may be some of the most difficult to acquire.

The acquisition of land has posed new challenges to the operation at GNP. That is to manage the land acquired, both inside and outside the proposed boundaries. The challenge has numerous dimensions. In spite of 107 years of experience in managing national parks in Canada, CPS has no experience and very limited expertise to manage a grasslands ecosystem. Early investigation show that expertise in managing grasslands in a national park context is equally sparse in other jurisdictions. We are therefore, pioneers in this regard —pioneers trying to re-establish, to the extent possible, what the pioneers to the prairies encountered. We know as we begin that many components of that early ecosystem have been lost forever.

The primary task is to define the essential elements and describe their condition, then we can embark on the task of achieving them. This rather simplistic approach is already beset with hurdles.

There is a fairly well publicized local debate of how grasslands should be maintained. Ranchers, quite predictably, believe that park-acquired lands should be grazed to maintain species diversity. Others proposes the opposite treatment. The answer lies in research.

While most of the land acquired is undisturbed natural prairie, there are also pieces that have been broken. Some land which was abandoned in the 1930s has naturally established itself, some has been seeded with exotic species while some is under active cultivation. Rehabilitation of these areas poses interesting challenges but also provides equally interesting research opportunities.

Of concern, but perhaps out of reach, is the management of the Frenchman River, the central theme of the West Block. The natural flow of this stream has been manipulated since 1937. The result is that every piece of flat ground along the Frenchman has been broken and seeded to high yielding exotic grasses. Much of the riparian habitat has either been destroyed or significantly altered. Manipulation of the Frenchmau is certain to continue; not so certain is the implication on the park ecosystem.

Perhaps the greatest challenge of all is to establish a national park in an area far removed from any other national park. In this situation, local residents are not aware and often unsympathetic to the national park concept and management principles. For example, it is a commonly held local view that any grass that is neither grazed nor harvested is wasted. Similarly lost hunting opportunities on park lands are also viewed as wasteful. Some even question the need to protect prairie dogs (*Cynomys* spp.) and rattlesnakes—they don't have any obvious or direct economic benefit. Surely appreciation and support for park principles will grow, but only after concentrated efforts by park staff with support from conservation organizations.

The current economic environment in the world and the attempts by governments to hold the line on spending is frustrating efforts to establish the park. Funding for land purchases is becoming precarious. The credibility of federal/provincial initiatives may be questioned yet another time.

While the challenges may appear formidable, they can be met with the help of those who may be willing to take advantage of the opportunities that are provided. The recent application by The Provincial Museum of Alberta under the Eco-Research, Tri Council Green Plan Program is a prime example of a cooperative endeavour that will provide mutual benefits.

The greatest need exists in the area of long term monitoring of the grassland ecosystem in response to certain treatments. The recently approved Park Conservation Plan is a useful document to identify research needs from a CPS perspective. It can also be used to identify research opportunities for researchers.

Together I am confident we can succeed.

WORLD WILDLIFE FUND CANADA ENDANGERED SPACES CAMPAIGN

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If one looks at calendars or books in which Manitoba is featured, more often than not our province is portrayed by our floral emblem, the Prairie Crocus (*Anemone patens*); or it's a view of a landscape from agro-Manitoba—hay fields cut in swaths ready for baling. This view doesn't change for visitors to our province arriving by air into Winnipeg—they see fields planted with crops of one sort or another.

But there's a different view of Manitoba—one that is shared by naturalists and nature lovers. When they think of Manitoba a very different picture comes to mind..., perhaps it's a memory of a canoe trip taken on a lake in the Canadian Shield, or a hike through Spirit Sands in Spruce Woods Provincial Park. It could be the snakes at Narcisse Snake Pits, or a quinzee in the midst of the Whiteshell Provincial Park. A trip to Oak Hammock Marsh to watch the fall migration is always a favorite, as are the autumn leaves on the Hunt Lake Hiking Trail. For those who venture further afield, there are the spectacular fall colours of the arctic tundra. Big Bluestem (*Andropogon gerardii*), one of the indicator species of tall grass prairie conjures up images of the first settlers winding their way westward. Others think of Elk (*Cervus elaphus*) bugling in the Duck Mountains. Adventurous souls have discovered caving opportunities, and even they contain their own breed of wildlife—Little Brown Bats (*Myotis lucifugus*). Some naturalists think of carving ski trails through untouched snow, while others reflect on a moody Manitoba morning.

These images paint a picture of Manitoba that is indeed unfamiliar to most Canadians and, for that matter, many Manitobans. Our so called prairie province is in reality, a transition zone where eastern forests meet prairie grassland, and rivers flow down off the Canadian Shield to prairie Lake Winnipeg. In fact, lakes and forests comprise 60% of Manitoba's geography. So much for our prairie image.

But there's more to this beauty than meets the eye. Contained in this beauty is a great treasure in which a trained eye sees thriving ecosystems and biological diversity. Biological diversity? Some would say, what do those words mean? Just more jargon to throw my way? Simply stated, biological diversity is the wealth of life on earth, the millions of plants, animals, and micro-organisms, the genes they contain, and the intricate ecosystems they help build into the living environment. One measure of the extent of biological diversity is the number of species in an ecosystem. Let's take an example.

Let's look at a mixed forest on a ridge in Grand Beach. There's a great diversity of tree species in this forest, and on the forest floor, other plant species, like fungi and moss. And all around, the decaying matter and bacteria that helps to recreate the soil from which the trees grow forth. This habitat supports other species of wildlife such as the Ruffed Grouse (*Bonasa umbellus*).

Let's look for a moment at a different forest—a planted or managed forest. This forest is a monoculture, that is, all the trees are of one species. And if you look at the forest floor, you see a lack of understory or non-tree species and perhaps a lack of wildlife as well. This forest is also an example of a second measure of biological diversity, the variety within a particular species. A planted forest of all one type of tree coming from the same seed stock may not have the variety within its species that a naturally reforested area would have.

Today there is great concern about the loss of biodiversity (McNeely et al. no date). The ecosystems created by the interaction of plants, animals, and microorganisms with the air, water, and soils result in a balance of nature. The loss of diversity may disrupt this balance and the fundamental biological systems and processes upon which all life, including human, depends.

There are other concerns about the loss of biodiversity (World Wildlife Fund [WWF] 1988). From earliest time, people have made use of extracts from plants and animals in the wild for medicines. Our only means of providing strong resistance to disease in our main food crops is by cross-breeding them with resistant strains or wild varieties. Protecting natural areas such as the tall grass prairie ensures the availability of a genetic storehouse or natural pharmacy from which new strains of domestic crops and new medicines can be derived.

Manitoba is relatively young, having emerged from the Ice Age only 12,000 years ago—Churchill, only 5,000 years ago—and our species are still diversifying. We need to protect large areas in their natural state if we are to realize the full potential of this continuing diversification.

The retention of biodiversity, and the continuing adaptation and selection process of the best genetic material are key reasons why we need to protect areas in their natural state. What are other reasons?

Species are the building blocks of ecosystems, and indicators of ecosystem health. We can look to various indicator species in an ecosystem to tell us how part of that system is operating. Protected areas that are allowed to remain in their natural state, form natural laboratories for scientific study, and serve as benchmarks against which we can judge the health of more developed areas.

To save endangered species, such as the Burrowing Owl (*Athene cunicularia*), and prevent others from becoming endangered, we must protect or restore their habitats, our endangered spaces.

Extinctions of plant and animal species are a natural ecological and evolutionary process. Within historical times, however, the rates have accelerated to the point where, in the last decades of the twentieth century, the rate of extinction will be somewhere between 40 and 400 times the rate over geological time. While a number of species protection measures have been effective, such as the Peregrine Falcon (*Falco peregrinus*) Recovery Project in and around Winnipeg, and the Plains Bison (*Bison b. bison*) in Riding Mountain National Park, species are best conserved as parts of larger ecosystems. There they can continue to adapt to changing conditions as part of their respective communities; or withstand natural disasters such as fire. Everything in an ecosystem is interrelated, and we have to provide a large enough area for these interactions to occur naturally, for species to migrate as they have over centuries, and to allow adaptations over time to such things as climate change.

What do we do about this loss of biodiversity and the increase in the endangered species list?

In 1987, the World Commission on Environment and Development issued a report called "Our Common Future". This report recommended that one of the ways to address the loss of biodiversity was to protect representative areas of all the earth's ecosystems free from human development. The report also said that we need to increase the earth's lands and waters that are currently protected from four percent to twelve percent.

In 1989, WWF Canada took up the challenge posed by "Our Common Future" with an ambitious campaign to protect representative areas of the natural regions in Canada, the provinces and territories, such that when all the areas were added up, we'd have protected about 12% of Canada's lands and waters (Hummel 1989). And they set out to do this by the year 2000. They called this ambitious undertaking the Endangered Spaces Campaign (ESC).

From the beginning, the campaign had its work cut out for it. In Canada, after 100 years of conservation work, we had only managed to protect 3.6% of our country's lands and waters, and only half of our national natural regions free from development that severely alter the landscape—development such as logging, mining, and hydro. But let's turn our attention to Manitoba.

Manitoba has twelve natural regions, which have been designated by the provincial Department of Natural Resources. These natural regions have been classified according to their physiography, their vegetation, and climatic zone. Each natural region is representative of a different ecosystem. So the goal of the ESC in Manitoba, is to protect areas in each of these natural regions sufficiently large to adequately represent the area.

This means that we can't circle a huge area in the northern transition zone pictured here and say we've done the job of protecting our lands and waters. We need to have representative areas preserved in each of our natural regions. How do we protect lands and waters in Manitoba?

Most of the areas we will want to protect exist on Crown lands. National and provincial park classifications are one way in which we protect lands and waters that are under the jurisdiction of the Crown.

However, we have normally drawn park boundaries to reflect the spectacular or unusual; borders which reflect considerations other than ecological ones. If we are to use park classification as a means of protecting natural areas, we need to change our thinking and draw boundaries that reflect an image of parks as biological reservoirs, to increasingly emphasize their role as ecological preserves, and to reduce pressures for development that would have a negative impact on the habitat and wildlife within their boundaries.

Other means by which we protect areas in Manitoba include Ecological Reserves (ERs) and Wildlife Management Areas (WMAs). These tools are somewhat lacking, however, in that ERs tend to be very small sites which cannot withstand pressures from outside their boundaries, and WMAs allow human activity within their boundaries that may negatively impact on their ecosystems.

Even our provincial parks have drawbacks. Only one classification—wilderness park—prohibits major resource extraction. In fact, major resource extraction such as mining and logging, continue in most of our provincial parks and even our one wilderness park is open to mineral exploration. To meet the protection requirements of the ESC, we need to strengthen our legislation such that it will protect areas from development for all time.

Let's take a look at Manitoba, and see what kind of job we have done of protecting those lands and waters under jurisdiction of the Crown. Adding up all of the areas to which we have given some kind of protective status—national parks, provincial parks, ERs, and WMAs—we come up with a figure of about 9.7%. Not bad when you compare it to the goal of 12%. If we remove all those areas that have insufficient protection under provincial legislation, and those areas that are inadequate in size, we're left with less than 2%: our one national park: Riding Mountain, Atikaki Provincial Wilderness Park, the Mantario Wilderness Zone in Whiteshell Provincial Park, Hecla Island, and Spruce Woods Heritage Parks—but even these contain major roadways and facilities. Remove these intrusions and you get about 1.2%. About one/tenth of what we'd like to protect under the ESC.

Another dimension to this issue is that only four of our twelve natural regions have areas protected within them. Clearly, we have our job cut out for us. What's going on in these regions that are unrepresented? Do we still have options left to preserve areas within them?

There is still time to save species and their ecosystems but time is running out. Already in Manitoba, we have lost the option to preserve large, roadless wilderness areas in the southern part of the province. Most of this land is privately held and we will have to look at private stewardship to preserve these areas. However, we need to recognize the contribution that private landowners will make to the campaign objectives through tax concessions for land left in its natural state as well as changes in agricultural policies that do not presently encourage landowners to retain land free from cultivation.

We are in danger of losing special areas in northern Manitoba, as more than 60% of our productive forests are included in the licensing areas of two forestry companies. We must identify areas within these license units that should be protected, before the areas are cut. A comprehensive forest policy that includes protected areas is required.

The Seal and Hayes rivers are the last two of our great northern rivers that are undeveloped. The estuaries of these rivers, together with the Nelson and Churchill rivers flow into Hudson Bay and create habitat for Beluga (*Delphinapterus leucas*) that migrate to Hudson Bay each summer. But both the Seal and Hayes rivers are candidates for future hydro development. While we derive great benefit from these hydro projects, we must also be aware of their effects on the Hudson Bay ecosystem. Ontario and Québec are also adding pressure to this eco-system through hydro projects of their own and these combined effects may significantly alter the habitat in the Bay. While the western Hudson Bay population of Beluga is still thriving, those of eastern Hudson Bay, the eastern Arctic, and the St. Lawrence River are on the national endangered species list.

Roads not only cut through the landscape, but they open up areas and allow increased accessibility leading to increased pressures on wildlife that were previously protected by their remote location. Herbicides are used to control growth along their edges destroying plants and insects thus having an effect all the way up the food chain.

I have looked at the areas we have protected in this province. Now I will review those that we have developed or have targeted for development. The combined impacts of hydro, forestry, mining (Zahalan 1980), agriculture, major roads, and railroads, developments and proposed developments will change well over 60% of the province irrevocably and forever.

Clearly there is a need for a more balanced approach; a place for preservation at the decision-making table. And this balanced approach has its other benefits, aside from the preservation of species and biodiversity.

Protected areas provide opportunities for economic diversity such as tourism, particularly in remote wilderness areas where resource extraction has always played a large role in economic development. Wilderness trippers require support services and guides for their travels. Diversification of local economies provides stability, just as diversity in a biological community provides stability.

Where would Tom Thompson, A.Y. Jackson, Emilie Carr, Bill Mason, and our own renowned photographer Robert Taylor be without natural areas, wilderness and wildlife from which to draw their inspiration? Where would we all be without wildlife to look at. Wildlife viewing and photography are two of the fastest growing industries in North America. Until this last year, bird watching was the biggest sport in North America.

Most justifications for the preservation of wilderness and natural landscapes are based on economic and utilitarian arguments—just as the ones I've given here. But what about nature for the sake of nature. John Livingston, writing in *Endangered Spaces: The Future for Canada's Wilderness* (Hummel 1989), says that "any attempt to make a case for a park other than the human one is difficult. We cannot prove (nature) out by cold logic or numbers. But as every naturalist knows, nature is not rational or logical." Surrounded by nature, we experience a profound sense of well-being and joy—the fresh smell after a spring rain, the rustling of leaves in the wind, the haunting cry of the loon.... Retaining natural areas ensures that there are places for us to go when we seek spiritual renewal and rejuvenation.

Wilderness speaks to the heart of all of us and binds us together as Canadians. It's part of our psyche and helps define us as a nation. Can we imagine Canada without wilderness?

Canada's aboriginal peoples hold deep and direct ties to wilderness areas throughout Canada and seek to maintain traditional wilderness use. *Our Common Future* asserts that aboriginal peoples have the right to be involved in planning and decision-making regarding natural resources (World Commission on Environment and Development 1987).

In summary, wilderness sustains a range of values including aesthetic, cultural, spiritual, economic, scientific, and therapeutic. But as visionary Aldo Leopold (1949, page 199) said, "Wilderness is a resource which can shrink but not grow. Invasions can be arrested or modified in a manner to keep an area useable either for recreation, or for science, or for wildlife, but the creation of new wilderness in the full sense of the word is impossible."

Our Common Future says that the preservation of representative areas of our ecosystems "is an indispensable prerequisite for sustainable development. Our failure to do so will not be forgiven by future generations" (ibid., page 166). This means that preservation has to become part of the thinking and decision-making process in all our developments and land use in Manitoba and has to be done first before we foreclose our options. Once developed it's gone, but if protected, all our options, whether they be for continued protection or for development, are still wide open.

Are we listening? Well, I think so. At the time of the provincial election in September 1990, Premier Filmon committed to completing the agenda set out by the ESC becoming the first province in Canada to do so. Since then, Manitoba has been joined in its commitment by all other provinces and territories except New Brunswick, Québec, and Alberta. The Federal government has also committed to doing its part by completing its national terrestrial parks system by the year 2000.

Quoting from Premier Filmon's words spoken at the launch of the ESC in Manitoba in February of 1990: "Sustainable development is a grass-roots concept. It depends on the active involvement and participation by all citizens to find solutions to problems, to identify opportunities and to mold the type of society that will meet our needs and those of future generations. The concept of maintaining wilderness into the future is both a source of inspiration and challenge. There is still much work to be done."

Protecting lands through official designation is one thing, but what can we as individuals do?

Join the over 415,000 Canadians who have signed the Canadian Wilderness Charter which sets out the goals and vision of the ESC. Get others to sign the charter.

Join or support an environmental organization that is working actively to support the campaign, such as the Manitoba Naturalists Society and get involved as an active volunteer.

Get and read a copy of the book *Endangered Spaces: The Future for Canada's Wilderness* (Hummel 1989) or make a donation to the ESC to ensure that its message continues to be heard across Manitoba.

Be a prairie patron and buy an honourary deed to an acre of tall grass prairie. Help create the Tall Grass Prairie Preserve in southeastern Manitoba or nominate an area that you think should be protected.

The task ahead of protecting natural areas is one that will take much effort, collaboration, and cooperation. It will take the education and involvement of each and every one of us. It will take understanding the impacts, on local residents, of protecting lands and waters. It will take understanding the impacts on industry and finding new ways of doing business—together. It is a task that will take commitment and a collective will to see it through. I believe this will exists; after all, can we accept Canada and Canadian life without wilderness?

LITERATURE CITED

Hummel, M. 1989. Endangered Spaces The Future For Canada's Wilderness. Key Porter Books, Toronto, Ontario, Canada.

Leopold, A. 1949. A Sand County Almanac. Oxford University Press Inc. New York.

McNeely, J.A., K.R. Miller, W.V. Reid, R.A. Mittermeier and T.B. Werner. No date. Conserving the World's Biological Diversity. The World Bank, World Resources Institute, IUCN, Conservation International and World Wildlife Fund.

World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press, Oxford.

World Wildlife Fund. 1988. The Importance of Biological Diversity. A Banson Production. Yale Press.

Zahalan, R.G. 1980. Mining in Manitoba. Manitoba Department of Energy and Mines Mineral Resources Division.

THE NEED FOR COOPERATION ON PRAIRIE CONSERVATION

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I'm not sure that Garry Trottier's introduction of me as a hunter makes me feel all that comfortable in this crowd dominated by naturalists! But I don't make any distinction between hunters and naturalists since we are all conservationists, so I guess I don't have to worry.

I want to focus today not so much on specific techniques but on the fundamental approaches to prairie conservation. Lets try to "see the forest for the trees." Our Saskatchewan programs and experience won't be specifically mentioned but will be reflected in what I have to say.

I want to talk about the two camps we're dealing with here: 1) agriculturalists (including farmers/ranchers); 2) conservationists (including hunters and naturalists). I include associated agencies and organization in these groups.

What is the background relationship between these two groups? There isn't one, at least nothing to speak of! There's been very little communication and cooperation between them. There is Ducks Unlimited's long history of working on private land. And there are some other fledging efforts to work together, notably under the North American Waterfowl Management Plan. But basically this has been a black and white situation. We've gone our way and they've gone theirs. That's got to change! Some underlying things have to change first, notably respect and recognition for one another.

As conservationists, we need to show more respect for the men and women on the land. Most of them do love the land. It may take a little different form from our love of the land—but it's love nonetheless.

Secondly, we must recognize that they, the grain farmers, are in a desperate economic situation. Nobody is making money these days, not even the best of farmers! They're just hanging on by the skin of their teeth and with considerable help from us through government support programs or "handouts." There are a lot of jokes and cynicism about this support, but would we have a century old industry, complete with hundreds of thousands of people, go down the drain virtually over night? I don't think so! And we have to take an understanding view of land use practises, including the practise of cultivating every square inch that is possible. Intense cultivation has been heavily encouraged by our society through government agriculture policies and programs. Is the farmer liable to leave much native habitat if the only way he can market grain or qualify for support payments is on a cultivated acreage basis? Not bloody likely!

So I think we have to have a little sympathy for farmers. Maybe this is just my farmer roots showing through! I gladly confess to having those. But what I've just said is fact, as far as I can determine.

By now you may think I view the farming community as above reproach, as white knights in shining armour who just happened to have fallen off their horse and need a bit of help to get back on? Not really! Their armour is pretty tarnished, even rusted through in places.

Farmers need to recognize their industry depends on the health of the environment and that other animals and people share that environment. Their attitudes are a reflection of 100 years of subjugating nature in this part of the world. This has to change. We all, including farmers, have to start working with nature and living in harmony with it. They must realize that the productivity they've experienced has been on the back of virgin prairie soils and that the gravy train is coming to an end.

Farmers also must recognize that Canadian society and their governments are soon going to be wanting more bang for their buck. They're going to be wanting some environmental return for the farm support dollars.

So were do we go in the future?

Well, what we really need is a lot more communication and cooperation! There's far too little of this between the farmer and conservationist camps (and in the world in general) these days. Things are also conspiring to force us to cooperate, just as they did in the early history of prairie farming (i.e., the "bees"). This culminated in the formation of major cooperative institutions during the real tough times of the "dirty '30s." I'm talking about things like the Wheat Pool and the Canadian Commonwealth Federation party, of course. There are a lot of similarities between that period and today, notably, a lack of resources. But what are the responsibilities of, first of all, the agriculture camp?

Farmers must show more responsibility for soil and water conservation. Wildlife habitat conservation goes hand in hand with this, as we know. Specific attention to wildlife habitat is also appropriate. Do what you can afford to do for wildlife, should be the message to farmers. They should also take responsibility for working with conservationists on mutual interests.

Conservationists must start communicating with the farming community. As Cool Hand Luke said in that famous movie "what we have here is a failure to communicate!" My apologies to our American guests for the attempted United States accent! We must start giving them information about ecological relationships and how to conserve wildlife, not telling them what to do.

We must also embrace the principle of private stewardship. We haven't always done that up to now—myself included. The vast majority of land on the prairies is privately owned (or controlled) and will remain so. The World Wildlife Fund (WWF) is showing leadership in this area through their enlightened land tenure criteria for protected areas.

We also have to be real careful about the position we take on land use. I'm sure glad I checked with Monte Hummel yesterday on the WWF position on this before I got up here today! I was all ready to blast them for what I understood their position to be on grazing and petroleum development, namely that they were outright opposed to it. He assured me that wasn't the case—that they were not opposed to it and looked at every case on it's merits. That's good, because it isn't realistic to expect to reach the admirable endangered spaces goal in the grassland without living with these land uses. But equally pertinent, they do not necessarily have a significant negative impact on natural areas. We have to recognize there aren't going to be any more grassland national parks (I will bet). It's going to be a jewel, but we can't hope to accomplish all our conservation goals through park creation. It just isn't going to happen! Similarly, outfits like my department are going to have difficulty expanding other parks and we're not going to be able to buy everything either. We have to look for other ways. Private stewardship is one of those ways, and joint ventures with agricultural organizations and agencies is increasingly a possibility.

I see private stewardship taking various forms from landowners doing their own thing on one end of the spectrum to nougovernment organizations (NGOs) buying land with private funds, and everything in between. This must largely be driven by information. We've got to be prepared to invest some serious dollars in this! It may seem like a waste of money to advertise etc. but it's probably the most cost-effective in the long run. There's an especially great potential to apply private stewardship to the "sexy" endangered species!

But we can't "throw the baby out with the bathwater." We have to maintain the important initiatives on Crown land. Nature conservation must be formally recognized as a legitimate use of some of our Crown lands, mostly as one of several compatible uses of the same piece of land. Legislation is the best way to go—it's much more permanent than a policy decision, which literally can be changed with the stroke of a pen! You just have to be prepared for the long haul, including the backroom lobbying, to get such legislation as the Saskatchewan Critical Wildlife Habitat Protection Act. Unfortunately, traditional Crown land users perceive this as the "stick" approach and I don't know how to get around that. It has to do with fundamental differences in philosophy concerning the public versus the private domain.

Purchase programs will probably have to be deemphasized, although it will hurt us to do it. Hopefully, we can always maintain the ability to do this on a selective basis. Sometimes there is just no substitute! But we'll have to put a lot of money elsewhere. Within this program, we should also divert some resources from purchase budgets to better, cooperative management of the lands we now control. This is for two reasons to: 1) get better management and public use of the holdings; and 2) ensure that they stay in our possession; a sense of ownership by the public will stand you in much better stead when the chips are down than the piece of paper which is the title.

And finally, for the biggy, which we have to do in cooperation with agriculture. All of society has to share this baby!

I'm talking about reform of agricultural programs and policies, of course. This will do more for nature conservation than everything else combined! We in the conservation field don't have control of the agenda here but I believe that the environmental concern is strong enough in this country that we can presume to have an influence, perhaps a pivotal one. How do we do that?

Well, you've probably got just as many good ideas as I have, but I will offer a couple of general thoughts.

While respecting the importance of agriculture and the people in it, we shouldn't be intimidated by it any more. As the saying goes "they put their pants on in the morning the same way we do." And they're opening up to environmental concerns. Witness the recent navel gazing the federal and provincial Ministers of Agriculture did, culminating in the adoption as policy, of the very progressive document called Growing Together (Federal-Provincial Agriculture Committee on Environmental Sustainability 1990).

And lastly, let's do something, don't just talk about it. I'm reminded here about the poster showing two vultures sitting in a tree looking out over the desert. One says to the other "Patience my ass, I want to kill something!" I identify with that vulture! The studies have been done (i.e., Girt 1990); the negative relationships are pretty well known. We now have to work to effect change using the tools and the avenues available to us. Bureaucrats like me have to get with it within our circles and the NGOs and private citizens have to exert their considerable influence. We both have our power.

Well, I hope I've been fair in my comments today. I also hope they provoke a little discussion and thought. I'd like to reiterate my thoughts here today that what we need more of is cooperation in the prairie conservation arena. With more of that all around, the present opportunities will be maximized.

LITERATURE CITED

Girt, J. 1990. Common Ground. For Wildlife Habitat Canada, Environment Canada and Agriculture Canada, Ottawa.

Federal-Provincial Agriculture Committee on Environmental Sustainability. 1990. Growing Together. For Ministers of Agiculture, Agriculture Canada, Ottawa.

RURAL MUNICIPAL CONSERVATION - WORKING WITH MUNICIPALITIES IN DELIVERING CONSERVATION PROGRAMS

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It is my experience that if any agency wants to succeed in delivering a conservation program in prairie Canada, that agency must deal in good faith with the rural municipal (RM) or local government district (LGD) council representing the ratepayers of that particular land base.

Having said that, conservation program delivery agencies in general, and some wildlife agencies in particular, have been slow to recognize this fact. In our enthusiasm and zeal to get conservation program elements on the landscape, delivery agencies have often bypassed the local municipal government in favour of dealing directly with the landowner.

In Manitoba, this has caused serious problems, particularly prior to the 1980s, when lands purchased by the Crown for wildlife designation were exempt from municipal taxes and consequently were lost to the municipality as a tax base. Obviously this was of concern to local governments. Currently, the Manitoba government pays the appropriate municipality a grant in lieu of taxes on any Crown Land designated for wildlife management purposes.

It is not always easy to obtain support of local governments for conservation programs. Here are obstacles you may encounter when you solicit the support of the local municipal council for delivery of a conservation program in that RM or LGD.

Some RM's have had bitter experiences with former programs and view new initiatives with a jaundiced eye. (They don't buy the line "We are from the government and we are here to help you.") Problems with wildlife damage to farm crops, bad experiences with other government agencies and representatives, and municipal assessment problems are just a few of the examples that I have encountered.

We must recognize that councils are extremely busy and are under a great deal of pressure. They are besieged by delegations concerned about problems with local social and physical infrastructure and are under constant pressure to provide services within a reasonable tax levy. The challenge of maintaining the education system, roads, health care, and a wide range of other services is uppermost in the minds of most councillors. Therefore, it is not uncommon for councils to give short shrift to ageucy representatives that appear before them peddling one sort of conservation program or the other. This is particularly true if the program doesn't appear to be friendly to agriculture or, in fact, appears to infringe upon the producer's income and therefore the tax base of the municipality.

Councillors are only human and that is sometimes reflected when they allow very strong personal biases against a program or the delivery agency to colour their judgement when, in fact, that program may have significant value for the producers and their land. For example, a councillor may have been a victim of duck damage so he may take a dim view of programs to produce more ducks.

There have been, and are, situations (although rare) whereby a municipal council does not represent the ratepayers when it condemns a particular conservation initiative. Conversely, municipal councils are sometimes much more progressive in their thinking than the folks they represent. This may inadvertently lead you to believe that their ratepayers will welcome you when you call but, in fact, they may be very cool to your proposals. I bring these points to your attention lest some of you are left with the impression that to work with and secure the approval of a municipality all you have to do is simply "waltz" in with your flip charts, overhead slides, and nice coloured maps and expect the local council to welcome you with open arms.

Perhaps the best way to secure the approval of a municipal council for your conservation project is to develop and/or solicit the support of local residents or organizations as an advocate. For example, when the Manitoba Wildlife Branch promoted the protection of undeveloped road allowances by urging municipal councils to pass bylaws prohibiting destruction of these ribbons of habitat, it was the dedication of the local Conservation Districts and wildlife associations that helped to persuade those councils that passed and supported such a bylaw.

Wildlife program managers in Manitoba have had excellent success in using local advisory committees to bridge the gap between local municipal governments and the agencies delivering the conservation program. The Manitoba experience comes from various large habitat initiatives such as Heritage Marsh projects and the Habitat Enhancement Land Use Program (HELP) in the RM of Shoal Lake. Our most recent experience with local advisory committees is related to the coordination and delivery of the North American Waterfowl Management Plan. In 1991, the Manitoba Habitat Heritage Corporation invited 10 to 12 producers in each of our four program delivery areas to sit on a local Liaison Committee in their respective areas. At least one of these individuals is a municipal councillor from the local community. These four advisory committees provide a means for information exchange and feedback among program delivery people and local communities. In my opinion, that type of local input is a prerequisite for the successful delivery of conservation programs on private land in prairie Canada.

An important element in the acceptance and support of the local RM for a conservation program is to place your field delivery staff in the local community. This may cause an increase in your start-up costs but it will pay big dividends in the success of your program.

Once you have received the blessing of the local RM for your project, how do you maintain that support? Here are a few suggestions.

It is important to provide regular program updates to the local municipal council in person because you cannot always rely upon the council's representative on your local advisory committee to do an adequate job. You should also realize that councils sometimes lose touch with their ratepayers so don't assume that approval of the local advisory committee automatically means approval of the local municipal council.

Keep in mind that municipal councillors are politicians and a very key component to our democratic form of government. Therefore, as your conservation program gains momentum and builds support in the community, make sure the municipal council gets some of the credit. Landowner appreciation barbecues, fowl suppers, and project dedications are excellent means of giving recognition to municipal officials. Ducks Unlimited Canada has successfully used project dedications to this end and the Delta Waterfowl Research Station, for years, has hosted a landowner appreciation barbecue for Minnedosa area farmer-cooperators in Manitoba.

In closing, I reiterate that the support and guidance of the municipal government in your project area is virtually a prerequisite if you hope to be successful in any long-term conservation initiative in prairie Canada. And the key to the support of the local council is honest and frequent communication in plain language.

LAND MANAGEMENT: A PERSONAL VIEW

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The area that I am from in south-central Saskatchewan was first settled by ranchers in the 1880s. In the winter of 1906/1907, 80% of the cattle on the open ranges died of starvation or exposure. This was the end of the large company ranches on the open range. The prairie lands were opened up for homesteading and soon we had large numbers of people breaking up vast acres of mature prairie land. Much of this land was not suitable for farming and many of the homesteaders were not equipped or prepared for the pioneering hard times that lay ahead. The drought and the depression of the 1930s caused an ever increasing exodus of farm families.

In the 1930s the government, through agencies such as Prairie Farm Rehabilitation Administration, started rehabilitating some of the blown-out land. Through the use of Crested Wheat Grass (*Agropyron cristatum*) and other plants, community pastures (both federal and provincial) were organized. This encouraged the production of livestock, mostly cattle. In the 1930s it was discovered that the family rancher or the mixed farmer was better able to cope with the economic and drought conditions of the times and since then, southern Saskatchewan has had a fairly strong, viable cattle industry. With proper usage and management, the Palliser triangle area has proven to be a good agricultural production area for both grains and livestock.

On a personal basis, I was the fourth child of 12 born to a ranching family in the Wood Mountain area. In 1937, the driest year of the 1930s, commodity prices dropped to an all-time low. Cattle were selling for as little as 1¢ per pound. It was this year (1937), at the age of 17, that I bought my first quarter of land. The price was $150 and I also purchased 60 head of sheep at 5¢ per head. I borrowed the money from a dentist uncle in Turva, United States with interest at 6%. Two years later I traded 10 horses for a contract on some provincial government range land. This pasture land is within the core area of the east block of the Grasslands National Park (GNP).

From this modest start in the 1930s in partnership with my youngest son, we have built up our ranch to 31 sections (19,800 acres). Of these 31 sections, 20 are Crown land leased from the Government of Saskatchewan and 11 are deeded land. The eleven sections of deeded land (7,040 acres) are a mixture of agricultural farm lands and mature pasture land. We farm 1860 acres on a half and half summer fallow basis, with 800 acres of farm land seeded to pasture and hay and the remaining 2660 acres left in its native pasture state. Our holdings are divided in two ranches of equal size. One is located near the east block of GNP and the other is 90 miles east in the Big Muddy Valley between Minton and Big Beaver.

Now what about wildlife. In the 1930s we had Pronghorn Antelope (*Antilocapra americana*) in good numbers, Sage Grouse (*Centrocercus urophasianus*), Greater Prairie Chickens (*Tympanuchus cupido*), a few Gray Partridges (*Perdix perdix*), some ducks on the creeks, and a few deer. Since the 1930s deer and antelope have increased, Sage Grouse and Greater Prairie Chickens are fewer in number, and now, along with the Gray Partridge, we also have Ring-necked Pheasants (*Phasianus colchicus*), and we still have Burrowing Owls (*Athene cunicularia*).

Hunting seasons for much of the wild game started in the 1950s, and since then antelope have extended their range to the farming communities near Moose Jaw and Weyburn. The deer population (both Mule Deer [*Odocoileus hemionus*] and White-tailed Deer [*O. virginianus*]) have increased most dramatically, and in many instances the deer have caused much damage to rancher's feed supplies. At the present time, we are providing the grass shelter and habitat for at least 300 antelope and 150 deer, and protection for Sage Grouse, Sharp-tailed Grouse, Gray Partridge, and Ring-necked Pheasant. We are providing a living and safety for these animals because we have the native grasslands with the natural protection of the coulees, the trees, and the brush.

At the present time, the laws in Saskatchewan give us control of access to our lands. We don't care to hunt, we like our animals, but on the other hand we recognize that wildlife must be managed and harvested just like our cattle and sheep. Other than in the immediate area around our home ranch, we have always allowed hunting, mostly on a first come-first served basis. The majority of the hunters are good, however, once the hunting season starts in September, we live in fear of gates being left open and are even more fearful of a prairie fire caused by the hunters. We have also cooperated with people who want to picnic, hike, take pictures, or have trail rides or wagon trains. All we ask is respect for our property and grasslands. All tourists should keep in mind that the rancher's grass is the rancher's livelihood. What annoys me are hunters who will post their own land and then come and move freely over ours.

In Saskatchewan, we have had government programs that have paid for feed damage caused by deer, supplied material for fences, and provided feed for the deer. Many of these programs have now been suspended and there is more flexibility in the hunting of the deer that are causing the problem. Some of the above programs have probably been abused, if not abused they have been used more by some ranchers than by others. It doesn't seem right that a land owner can post his land (no hunting) and then collect damages for feed eaten by the deer.

Relationships between land owners and hunters are not the best. Much of our area is posted "no hunting" or "hunting with permission only." What are the answers to the present friction? I'm not sure, but it seems to me that all persons involved, including nature lovers, environmentalists, hunters, and government, have to realize that the land owner, who has kept some land in its native state, is the one who is protecting the wildlife and the plants and somehow these persons are entitled to some compensation. With the large four wheel drive tractors, very little of this native land is safe from being turned into grain production.

I recognize the fact that the animals were here before I was and therefore, I should have some responsibility to their keep. However, if as a result of climatic factors or government programs, the animals increase to unreasonable numbers, then it seems reasonable to me that I should be entitled to some compensation. If better cooperation is not achieved between hunters and land owners I can see more and more land being posted.

An extreme situation developed recently in Montana when Ted Turner of CNTV Atlanta bought a large range in a good hunting area. Mr. Turner immediately imposed a no trespassing and no hunting policy. The hunting fraternity of the area complained. Mr. Turner organized a public meeting and he told them that if they wanted to hunt they should buy their own land.

It seems to me that landowners in the settled areas of Saskatchewan are the ones who preserve the animals. Perhaps compensation could be paid on an acreage or assessment basis.

Now let us examine some other government programs. The person who has retained land in its native state or who has seeded cultivated acreage back to grass has been discriminated against by government programs. For many years the subsidized support programs have been calculated and paid mostly on the basis of bushels sold or on the basis of acreage seeded. The person who looked after his sub-marginal land has lost out on many of these payments. Over the years, the largest subsidy has been on the freight of grains for export or feed freight assistance through the Crow Rate and other payments. This has encouraged the breaking up and increased seeding of grains for export. Government should retain ownership of a lot of this native grassland. However, selling to farmers and ranchers is also a good idea to give the rancher some continuity. On average, I believe most ranchers are good responsible landowners; sometimes they will over-graze in difficult economic times. The government has a responsibility to see that we do abide by our contracts.

Regarding the GNP, I believe the policy of the park in regard to land acquisition has been fair, equitable, and reasonable. Those of us in the GNP area have been going through a lot of uncertainty for 30 years. Now the direction seems to have been established and, on the whole, I'm satisfied with what I've observed so far. The land acquisition will eventually come to a successful conclusion. Some of the problem areas will be wildlife and agitation for grazing privileges. I believe some grazing of livestock should be allowed. I believe cattle within the park will make it a nicer park for the tourists to visit and would also help maintain the viability of some of our local communities. However, I also believe this grazing (if allowed) should be on a well controlled basis. It is my belief that governments (parks), ranchers, cattle, and people (tourists) can get along and each can give and add something to the environment.

PUBLIC LAND MANAGEMENT APPROACHES FOR CONSERVING NATIVE PRAIRIE ENVIRONMENTS - SOME ALBERTA EXAMPLES

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As the agency responsible for the use, management, and administration of provincial Crown lands, Alberta Forestry, Lands and Wildlife is currently using a variety of approaches to conserve native prairie environments. In fact, in prairie and parkland Alberta the management, planning, and coordination resources of the department are increasingly being focused on this task. That may seem odd, especially if one holds a stereotypical image of this kind of agency as being one preoccupied with harvesting fibre from our forests, drawing Animal Unit-Months from our public native grasslands, and managing wildlife to yield game. In fact, the single sectoral approaches to resource allocation and management are increasingly viewed as dated by the public, by resonrce managers, and yes, even by politicians. This does not mean that such functions are in any way "on the way out," but it does mean that they must take place within a broader integrated context that recognizes other resource uses and values.

The Department of Forestry, Lands and Wildlife, like many agencies, has recently undergone a strategic exercise and our new mission statement (1991) is as follows: "As stewards of Alberta's fish, wildlife, forest and public lands our mission is to manage for sustainability, the integrated use of resources and a healthy environment in harmony with the need of Albertans."

This kind of statement signals a growing maturity in the way in which our common property resources are viewed. Specifically, our staff recognizes:

1. That provincial Crown lands and the multifarious resources that they sustain are a public resource, held in trust for Albertans.

2. That lands should be used and that rights to the use of public lands and resources may be allocated subject to conditions.

3. That public lands with significant multiple resource values such as recreation, habitat, conservation, and wetland values should be managed to retain those values.

4. That the department has a stewardship responsibility to ensure that public lands are managed in a manner that does not impair their sustainability and value to future generations.

5. That environmentally sensitive and significant lands deserve particular attention because: these lands are typically "vulnerable" to other resource uses; native grass prairie ecosystems are a non renewable resource; these lands constitute a small proportion of a landscape dominated by agricultural and cultural uses; and society's interest in the wise and responsible stewardship of our environmental resources is growing.

Our record is by no means perfect, but I think that the department is genuinely espousing a progressive ethic and is trying to balance effectively competing values for resource use in a way that is fair to disposition holders, to long-term public trust obligations and to the environmental imperatives of our time. The approaches currently being used to conserve our native prairie environments provide a good illustration of the way these responsibilities are being discharged.

The number of tools potentially available to achieve conservation objectives on public lands is large and growing. The major impediment to effective action across the board is not a lack of mechanisms or ideas, but rather resources—specifically funding for programs and manpower.

I'd like to provide a brief overview of a variety of tools that we're using together with an assessment of their effectiveness and limitations.

DESIGNATED PROTECTION

Designated protection is an obvious tool, but perhaps the most limited. The advantages of this kind of approach is that nature conservation values are designated as the highest and best use of the site. Through a combination of legislation and/or management plans other resource uses are carefully controlled to ensure that the primary values are not impaired. This generally works satisfactorily although, depending on the kind of site and its location, recreation uses frequently become the dominant priority. The main problems are as follows: 1) in settled Alberta, designated areas—with a couple of significant exceptions—tend to be small and fragmented and when we need to manage native prairie environments on an ecosystem basis, the ecosite approach (areas of 0.25 km^2 or larger) is inherently limiting; 2) the process of designation, public involvement, and management planning is extremely time and resource consumptive; 3) designated sites reinforce some polarized attitudes; they tend to be unpopular and perceived as a threat by many rural residents and once established they can make it more difficult to achieve environmental objectives on other lands—the "we've done our societal duty by protecting site X, and now leave us alone on the rest" syndrome; 4) they may protect key areas, but they often don't protect much; outside of the Eastern Slopes Forest Reserve, all of the designated lands in Alberta's central and southern administrative regions (which basically equate with prairie and parkland Alberta) constitute about 3.5% of all public land and only 0.7% of all land; note that these figures include provincial parks and provincial recreation areas, many of which are recreation sites with limited nature conservation value.

RESERVATION SYSTEM

The department operates a program that allows interested parties (usually a government agency), to register an interest against public land in the records of the department in the form of a "reservation/notation." The registration identifies public land and resources required to achieve particular land use or conservation objectives.

An interesting project is underway in our southern region to place protective and consultative notations on some key environmentally significant and sensitive public lands that are susceptible to surface disturbance and that currently lack adequate protection. Activities by the oil and gas industry in a couple of sensitive areas prompted the project. The intent is a stop gap measure to ensure that key sites are not lost between now and the time that comprehensive land use plans can be put in place. A total of 10 sites encompassing 1990 km^2 (777 mi^2) are being studied by Fish and Wildlife and Public Lands field staff. The placement of appropriate reservations on these sites involves a negotiated process with other interested agencies such as Alberta Energy and the Energy Resources Conservation Board. The amount of land within each study area on which reservations end up being placed ranges from 20-80% based on recent cases. The sites being considered include: 1) key sandhills, badlands, and unique areas which are significant for wildlife and are unique in elevation, topography, aesthetic qualities, etc. and where mitigation or reclamation is extremely difficult; 2) key wildlife breeding/rearing areas such as sage grouse dancing grounds and adjacent nesting areas, breeding sites for threatened wildlife, or rare species; and 3) sites with rare and endangered plant species on them.

The advantages of this mechanism is that it can be put in place fairly quickly and can cover a lot of land. Limitations include the fact that it is not comprehensive, is not permanent (reservations have to be renewed), and cannot be used with liberal abandon. The total number of reservations on public lands has actually decreased in recent years since too many agencies were using the system to "tie up" public lands with insufficient justification.

LAND ACQUISITION

Periodically, highly sensitive private lands are offered for sale to the department. An evaluation of the available sites is conducted with purchases focusing on those lands with major conservation concerns such as highly erodible areas, fragile slope areas, and important watershed management areas. Sites acquired are protected using the reservation system or may be acquired as candidates for formal protection through the Natural Areas Program.

A typical example of this kind of acquisition was last year's purchase of a 132 acre parcel of land along the Oldman River near Picture Butte. The parcel comprises mixed grass upland, fragile river breaks, and river floodplain having high wildlife value in an intensively developed agricultural area.

This kind of tool can be of great value in acquiring specific sites with extremely high environmental values that would otherwise likely be lost. Overall, however, it suffers from the same kinds of limitations associated with designated protection, but to an even greater degree—the amount of total land protected is extremely small. Also, this kind of approach is extremely susceptible in a period of fiscal restraint as Table 1 demonstrates.

Table 1. Funding for land acquisition programs.

	Conservation Land Assembly	Natural Areas Land Acquisition
1990-1991	$225,000	$310,000
1991-1992	$135,000	$200,000
1992-1993 (requested)	$120,000	$170,000

ENVIRONMENTALLY SIGNIFICANT AREAS (ESA) PROTOCOLS

Over the past several years ESA inventories have been undertaken for the vast majority of rural municipalities in prairie and parkland Alberta. These reports provide a reconnaissance level inventory of environmentally significant and sensitive areas—evaluating and classifying the relative sensitivity and significance of the areas identified as to their regional, provincial, and national importance.

A major limitation of these studies is that they are just inventories—while they do identify some management guidelines, these are merely the suggestions of the private consultant. There are two notable efforts underway, however, to facilitate the process of using the information in the reports to achieve conservation objectives on the ground as follows.

Planning Cooperation on Public/Private Lands

Alberta Forestry, Lands and Wildlife has negotiated directly with two regional planning commissions to seek common understandings on the way in which the reports will be used on both public and private lands and to identify areas where cooperative action is required. Areas in which "protocols" have been agreed upon include the use of the reports in both statutory (private) and policy (public) land planning programs, extension activities, cooperation with other jurisdictions, land trading, and cooperative planning.

Maintaining Wildlife and Habitat in Municipalities

The Prairie Conservation Coordinating Committee has struck a work group to follow up on a Prairie Conservation Action Plan (PCAP) recommendation that regional and municipal planning commissions should set objectives to protect wildlife and wildlife habitat on lands within their jurisdiction. The first step was the production of ESA inventories. Now that that task is largely completed, the work group is charged with the task of making recommendations about how these reports should be used to achieve habitat conservation objectives. The work group includes representatives of every regional planning commission in prairie and parkland Alberta. The chairperson has already identified for, discussion purposes, a "Hierarchy of Implementation Tools for the Protection of Environmentally Significant Areas." These include such volunteer measures as extension pamphlets, voluntary stewardship, stewardship enhancement tools (e.g., award programs), written agreements, and conservation easements as well as more regulatory approaches such as designation of an ESA through statutory planning exercises with various requirements (i.e., Environmental Impact Assessment).

These kinds of approaches have their limitations, notably in that they require a major resourcing effort at a time when resources are limited, in that there are a variety of viewpoints as to the most appropriate way to proceed, in that there are a lot of parties and interests involved, and in that the concrete use to which the ESA inventories can be put to in many situations is limited by their very broad, reconnaissance level nature. At the same time the potential rewards are enormous because until recently the number of tools available to achieve substantial environmental protection objectives on private lands has been most limited.

PUBLIC LAND USE PLANNING

Alberta Forestry, Lands and Wildlife coordinates an interdepartmental integrated resource planning (IRP) program which produces plans at regional, sub-regional, and local levels of analysis. Regionally-conducted land use planning exercises, "regionally integrated decisions" (RIDs) are also undertaken on an as-needed basis. Both kinds of plans are drafted by interdepartmental planning teams according to integrated resource management principles that require a holistic perspective on resource use issues, shared decision-making, and much cooperation, consultation, communication, and coordination. Meaningful public involvement is an essential ingredient of the process and the final plans go through an extensive review and approvals process usually culminating in ministerial or cabinet approval. These plans are policy documents that provide direction for the use, allocation, and management of provincial Crown lands and resources.

Historically, planning attention within the department has focused on those parts of the province where most of the public land is—the Eastern Slopes and boreal Alberta. There are now a number of plans at various stages of development, however, underway in prairie and parkland Alberta as follows.

Regional Plans

Broad strategic plans that focus on the coordination of government policy and resolution of regional policy issues. The regional plan for central Alberta has been publicly reviewed and is in final review and approvals. The draft regional plan for southern Alberta is being finalized by the planning team prior to public review. Both plans provide a description of ecological conditions and set goals, targets, objectives, and guidelines for fisheries and wildlife and ecological resources. The objectives of the PCAP are stated and reinforced.

Sub-Regional

An IRP is currently under development for the Plains Eastern Irrigation District which contains almost 600,000 acres of native mixed grass prairie. The planning team is part way toward developing a draft plan and is proposing a modified zoning scheme with the following three categories.

Protection Management Emphasis Area

Emphasis is on the protection of significant, sensitive, or unique landscapes and their associated flora, fauna, and natural processes.

Conservation Management Emphasis Area

Emphasis is on the conservation of the native mixed grass prairie ecosystem, improved grasslands, and wetlands.

Development Management Emphasis Area (MEA)

Emphasis is on the use of land and resources for development purposes (i.e., to permit activities that are not compatible with the Protection or Conservation MEAs).

An IRP will be initiated in the next few months for the Red Deer River Corridor in central Alberta. This will encompass some 600 km (375 mi) of river corridor with provincially significant historical, ecological, palaeontological, fisheries, wildlife, recreation, tourism, and agricultural values. Ecological resource considerations will be a major subject to be addressed throughout, but especially in the lower Red Deer River between Dinosaur Provincial Park and the Saskatchewan boundary.

Rumsey RID

In 1990, Alberta established a 13 quarter section Ecological Reserve in the Rumsey parkland area. Immediately south of the Ecological Reserve is a 50 section block of public land—Rumsey Parkland South. Together witb the ecological reserve, this constitutes the largest remaining block of aspen parkland in the world. Ongoing oil and gas activity in the Rumsey Parkland South area was a concern to environmental groups who would prefer to see designated protection for the entire parkland area. The RID was prepared to ensure that this unique ecosystem is maintained while continuing to allow for the responsible use of the area's resources. The draft plan has been publicly reviewed and is currently heing revised by the planning team in light of the public feedback.

In my personal opinion these kinds of resource planning exercises can yield the greatest potential benefits toward maintaining viable native prairie ecosystems on public lands. This is because they cover all of the public land base, at various levels of analysis, and establish resource allocation and use priorities as to "who gets what where" in a holistic manner. Moreover, if the process is fair and seen to be fair, the chances of a liveable outcome that meets environmental, social, and political objectives is vastly increased. Critics of this kind of tool can argue that these plans are policy, rather than statutory documents and that the level of decision making, even at local levels of analysis, can often avoid clear priorities and leave too many options open. Also, this kind of consensual, trade-off approach is not attractive to those who have an "all or nothing" agenda.

TAX RECOVERY LANDS

Alberta Forestry, Lands and Wildlife has administrative control of some 200,000 acres of tax recovery lands. These are private lands repossessed by the province for failure to pay taxes during the depression years. Most of the tax recovery lands were transferred to the administration of the Public Lands Division during the 1930s and were subsequently disposed under long term grazing leases. Tax recovery lands remain technically deed. While tax recovery lands are under lease, Public Lands has administrative control, but at lease renewal time, or if the lessee consents to withdrawals, jurisdiction reverts on request to the local authority. In many instances, tax recovery lands lie within large blocks of Crown grazing leases, or have substantial wildlife or environmental values, making their retention in public ownership desirable. Some local authorities have been pursuing the sales of tax recovery lands for some time.

From the perspective of the department, this raises several issues: 1) there are a lot of tax recovery lands in the Southern Region having multiple use values; 2) tax recovery lands are gradually reverting to local authority control and are being sold; 3) the opportunity to acquire tax recovery lands with significant multiple use values as public land is gradually being lost; and 4) public lands with high multiple use values are at premium in the Southern Region; these lands are also becoming progressively more important to society over time.

Accordingly we have being pursuing acquisition strategies in cooperation with individual rural municipalities. The approaches used depend on the particular situation and the intent is to try and produce win/win outcomes. Also our primary concern is the long-term security of the land base, rather than who has management control. To date we have been quite successful:

- Large scale exchanges of tax recovery lands with multiple use values for public lands with agricultural values were completed with the Municipal District (MD) of Cypress in the 1983 to 1987 period. The department acquired some 66,000 acres of lands with habitat and conservation values.

- The MD of Acadia had a sale policy for its 84 quarter sections of tax recovery lands that comprised of native prairie. After hearing about the PCAP, an ESA Inventory was undertaken and the Public Lands Division worked closely and cooperatively with the council working out a trade deal that would see public lands under Farm Development Lease transferred in exchange for tax recovery parcels of mixed grass prairie rangeland. The trade was approved in principle by the council, the ratepayers, and the local Member Legislative Assembly and is now underway. The vast majority of the tax recovery lands that have environmental value will be secured. The old sale policy has been changed to a protection policy.

Inventory projects to map and identify the multiple resource values of the tax recover lands have been undertaken for both the MD of Taber and the County of Vulcan. Departmental officials have held preliminary meetings with both councils to outline where we would like to go from here.

This tool is particularly valuable because of the large amounts of land involved and the level of ongoing interjurisdictional cooperation that can be established. A prerequisite is an environmentally progressive council and much good will and open-mindedness on both sides. The process of developing arrangements is time consuming, complex, and iterative. There are many potential pitfalls along the way. The final results, however, speak for themselves.

GOOD MANAGEMENT

In the final analysis the most effective way of conserving native prairie environments is through good land management. There are some 3.2 million acres of provincial Crown land under grazing dispositions in the southern region and since range condition is a direct measure of ecological status, if each disposition can be managed in a manner that sustains the range in good condition then vastly more has been achieved in the name of ecosystem management and environmental protection than could ever be the case through the acquisition of lands for conservation purposes or the designation of protected areas. Currently, approximately 50% of Alberta's rangelands have been described as overgrazed (Wildlife Habitat Canada 1991).

Public Lands Division works hard to discharge its land management responsibilities in this area in a number of ways.

Grazing Reserve Program

This supervised grazing program provides affordable summer pasture for Alberta's farmers and ranchers on public land while also allowing multiple uses such as: 1) Recreation Use - hunting, hiking, trail riding, camping, and sightseeing; 2) Industrial Use - oil and gas well operators, pipeline companies, gravel haulers, and seismic crews; and 3) Environmental Quality - wildlife habitat, special ecological resources.

The reserves aim to operate on a cost recovery basis and ensure a sustained yield from the pasture. Patrons are charged a grazing fee calculated on an animal/unit/month basis and pay for salt, minerals, and pharmaceuticals.

There are eight provincial grazing reserves in southern Alberta encompassing some 400 mi^2, most of which is native prairie. Two large reserves in the environmentally significant Lost River/Milk River areas of southeastern Alberta alone encompass some 240 mi^2 of native mixed grass prairie which is maintained in good to excellent condition.

Field Services Program

The field services program is staffed by land resource agrologists each responsible for lease management and administration in defined areas. They work cooperatively with lessees on a disposition by disposition basis, conduct periodic inspections of grazing leases, provide range management advice to individual lessees, and develop lease management plans.

Field Services also maintains a series of 29 native prairie benchmark sites which are used to monitor current range management practices and ensure long-term sustainability of the grassland resource.

Range Management Program

The goal of the Range Management Program is the conservation, management, and sustained use of the rangeland resource. This program area undertakes range inventories, applied research, extension services, and special projects (last year it provided technical assistance to the Siksika Nation in developing a range management plan for the reserve grasslands). To date range inventories have been completed on 188,000 acres.

Each of these three program areas make valuable contributions to the conservation of native prairie environments. The drawbacks, predictably, are in resourcing at a time of dwindling budgets and competing societal values. The Provincial Grazing Reserve program budget has been trimmed on a number of occasions, Field Services are understaffed by about 50% and there is a single regional range manager for the entire region. Moreover, this is a time of jurisdictional uncertainty when various options for the reorganization of agency mandates are under consideration.

The main conclusions emerging from the above overview of land management techniques are:

1. That there is no shortage of available mechanisms.

2. That the various approaches can be used in concert to achieve complementary objectives—there is no one "best" approach.

3. That multi-partite approaches are very much more common than they used to be and are yielding impressive results.

4. That public land management approaches that achieve environmental protection objectives can make a big difference to the environment, to meet the needs and gain the support of landholders, and can be socially and politically acceptable.

5. That effective resourcing is becoming a more intractable problem over time and that nothing can be taken for granted.

LITERATURE CITED

Alberta Forestry, Lands and Wildlife. 1991. Creating our future - Alberta Forestry, Lands and Wildlife's Strategic directions in the '90s. Alberta Forestry, Lands and Wildlife, Edmonton.

Wildlife Habitat Canada. 1991. The Status of Wildlife Habitat in Canada. Wildlife Habitat Canada, Ottawa.

PLANNING WITH THE PUBLIC: THE MILK RIVER NATURAL AREA AND KENNEDY COULEE ECOLOGICAL RESERVE

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INTRODUCTION

Located within the Mixed Grassland Natural Region of southeastern Alberta, the Milk River Natural Area and Kennedy Coulee Ecological Reserve have been at the focus of various conservation and management concerns since the early 1970s. After two decades of study, evaluation, and controversy, a management plan has been completed which is intended to provide the framework for conserving a representative example of the Mixed Grassland Natural Region in Alberta. This article describes the pros and cons of the planning exercise from the earliest discussions regarding area conservation and committee formation through plan development to implementation.

As concern over the loss of native grassland within Canada increased, the Alberta Wilderness Association began to lobby for protection of a large area in southeastern Alberta known as the Milk River - Lost River Region in the early 1970s. This marked the beginning of a series of evaluations by both federal and provincial governments aimed towards preserving the area as one of the last remaining large blocks of relatively undisturbed native grassland.

In 1976, Canadian Parks Service identified the Milk River Canyon as a "Natural Area of Canadian Significance" along with Val Marie-Killdeer area in Saskatchewan and the Cypress Hills. The Val Marie area was eventually chosen as the site for Grasslands National Park and Cypress Hills received provincial parks status.

Around 1978, the area in question was withdrawn from the Lost River Ranch in accordance with the Public Lands Act which placed limits on the amount of land allowed under grazing disposition. The Alberta government subsequently considered the area as a candidate ecological reserve, one of the first in Alberta. A great deal of controversy revolved around the size of the proposed area and the restrictions that would be placed on such traditional activities as hunting and grazing. With the help of a non-governmental body known as the Milk River Task Force, an agreement was finally reached in 1987 resulting in the establishment of a small ecological reserve bordered by a larger natural area.

The Milk River Task Force also recommended the formation of a committee consisting of both government and non-government members. This led to the establishment of the Milk River Management Committee containing six government and five non-government representatives. Over the last year, the Milk River Management Committee has completed a management plan which is intended to provide the framework for conserving this representative example of the Mixed Grassland Natural Region in Alberta (Hood and Gould 1992).

THE PLANNING PROCESS

The planning exercise was characterized by multiple use philosophies and public consultation throughout the process. The local integrated resource plan deviates from other integrated resource plans because of the direct involvement of local stakeholders in the planning process.

The early stages of this planning process cannot be touted as a shining example of modern day textbook strategy. Regrettably, the opposite is true and the process may be more aptly described as "backwards planning by forward thinkers." To support this statement, I submit the following facts:

1. The proposal for ecological reserve status came long before there was legislation to allow such a designation.

2. Initial attempts to involve the general public only served to alienate the local community.

3. A use of the area was proposed and tendered out for bids before a draft management plan was written.

4. And finally, the draft management plan was written before the committee assigned to that task was established.

PROS AND CONS OF PLANNING WITH THE PUBLIC

Although the early stages of the Milk River planning process did not follow a predetermined format, it served to spark a great deal of interest within the general public which otherwise may not have occurred. Directly involving members of the public on a voluntary basis fostered a sense of ownership in the resource, something which is often ignored in planning projects. It is my experience that the negative aspects surrounding this approach are far outweighed by the positive aspects.

Direct public involvement often suggests unnecessary delays. The public may not be entirely familiar with the area itself, the historical background, or government procedures. The Milk River experience suggests that the amount of time required to brief public members is insignificant compared to the delays resulting from previous government involvement.

A large planning team can become unwieldy. In order for the system to work, each voice must be heard and a consensus reached on every issue. Obviously, adding participants to the planning team, be they government or non-government, can lengthen the process. Nevertheless, the formation of a planning team must include the major stakeholders and interest groups to ensure a broad cross section of ideas and fair representation on issues.

Complications can arise when non-government members participating actively in the planning process use political ties to gain leverage on an issue. Members of the public have the right to access the powers-to-be directly whereas government employees must follow rigid lines of communication. However, these same political connections can be extremely helpful to circumvent a cumbersome bureaucratic hierarchy.

One of the problems specific to the Milk River planning exercise was the attempt to combine two separate areas which are administered by two different departments under the one plan. Both the ecological reserve and the natural area have separate internal planning structures and combining the two produced a planners nightmare. However, with no pattern to follow, the Milk River Management Committee was not bound by rules and was free to plot their own course.

THE PLAN IN OUTLINE

On the surface, this plan resembles many other integrated plans as it contains biophysical information, current land uses, goals and objectives, management issues and strategies, and agency responsibilities. It is in the implementation section that the plan begins to deviate from normal procedures. The Management Committee developed innovative solutions that would provide flexibility while at the same time ensure long-term protection for the area.

The nongovernment members of the Management Committee formed a registered society. The society was issued a twenty-one year recreation lease with the society bylaws tying the members directly back to the management plan. This ensured that the Committee would have control over the management of the site and not be bound by government bureaucracy. This allowed the society to enter into a long-term grazing contract with a local rancher of their choice, dictate the conditions of the contract, and alter the strategy depending upon the results of the monitoring program. In addition, the funds received by the society from this contract are put back directly into the management of the site rather than general revenue.

The Management Committee established a long-term monitoring program which is strongly tied to the management plan. The results obtained from the monitoring program will be used to evaluate the effects of management activities on plant and animal communities and on rare species and their habitats. Funds to support this program are derived from a variety of government and private sources.

CONCLUSION

Ultimately, the success or failnre of any planning exercise is not determined by the number of participants or whether they are government or non-government. Despite all the controversy, bureaucratic bungling, and endless delays, the Milk River experience demonstrated that planning with the public can be successful. This sneeess can be attributed to one thing. All the members of the planning team agreed that the Milk River area was special and that preserving a representative example of the Mixed Grassland Natural Region for future generations was justifiable. It was this underlying premise, more than anything else, that produced the high level of commitment necessary to overcome biases, open the lines of communication, and achieve problem solving by consensus as opposed to compromise.

In retrospect, a great deal can be learned from the Milk River planning experience. As was the case with Milk River, conflicting resource management issues often make planning a necessary evil. Given the increasing public awareness of environmental issues and a demand for input, planning with the public may become a standard practise. The challenge facing the Government of Alberta and specifically the Milk River Management Committee is, "Can we manage this area as well as our ranching predecessors?" In my own mind, the jury is still out and the verdict will not be heard for several years.

LITERATURE CITED

Hood, T. and J. Gould. 1992. Operational Management Plan: Milk River Natural Area and Kennedy Coulee Ecological Reserve. Public Lands Division, Alberta Forestry, Lands and Wildlife, Medicine Hat. 56 pp.

TALL-GRASS PRAIRIE CONSERVATION IN MANITOBA

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Manitoba is the only prairie province in which tall-grass prairie is found although tall-grass prairie remnants also occur in southwestern Ontario. Prior to the start of the following projects, only two sites comprising less than 50 ha were protected and managed as tall-grass prairie in Manitoba.

TALL-GRASS PRAIRIE INVENTORY

In 1987, the Manitoba Naturalists Society (MNS) initiated the Tall-Grass Prairie Inventory which was the first systematic inventory of tall-grass prairie in the province. Funding from the MNS and the World Wildlife Fund's (WWF) Wild West Program allowed for the hiring of two field technicians while the Manitoba Department of Natural Resources (DNR) provided office space and logistical support. Field staff located potential sites by using black-and-white aerial photographs, land use maps, and referrals from outside sources. Sites were subseqnently ground-checked and then ranked using native species dominance, abundance and diversity of native species, and evidence of disturbance as criteria. Although field staff surveyed only 19% of the primary study area that year, it was enough to document the rapid and continuing decline of the tall-grass prairie in Manitoba and to spur the interest and concern of government and other organizations.

TALL-GRASS PRAIRIE CONSERVATION PROJECT

Increased support from initial participants, and the inclusion of Wildlife Habitat Canada (WHC) as a funding partner, allowed for the expansion of efforts in 1988 and the project was renamed the Tall-Grass Prairie Conservation Project (TGPCP) (Joyce and Morgan 1989). Summer field staff increased to three technicians, and for one year, a cartographic technician and a project coordinator were hired. Inventory work continued while the project goals were expanded in an effort to generate an awareness of the importance of tall-grass prairie that would lead to its preservation. To this end, the project produced a brochure and a 20-minute film on Manitoba's Tall-Grass Prairie (the film is available in 16 mm or VHS video format from the MNS). The brochure has been widely distributed to landowners and the general public. In addition, the project solicited funding for, and acquired, two prairies. One of these, a 32 ha site, is now part of the Oak Hammock Marsh Wildlife Management Area and the other is a small 2.4 ha prairie in the Rural Municipality of Hanover.

By the end of 1988 the project had surveyed over 3000 potential sites in both the primary and peripheral areas. Of those, only 88 sites totalling 2000 ha were considered to contain good quality (C ranked or better) tall-grass prairie. The primary study area generally coincided with the basin of ancient Glacial Lake Agassiz and contained rich black soils which have been extensively used for agriculture. Only 22 sites with a mean size of five ha were found in this area. The largest site was 20 ha and only three other sites were 10 ha or more in size. One-half of these prairies were found on railway rights-of-way. The peripheral area, surrounding the primary study area, is characterized by poorer, stonier soils and has been primarily utilized as native hay and pasture. A total of 66 sites with a mean size of 29 ha were found in this area. The largest site was 120 ha and 20 other sites were 40 ha or more in size. Two-thirds of the sites in the peripheral area were on pasture or haylands. It is apparent that the majority of tall-grass prairie remaining in the province today is in the sparsely wooded areas of grasslands peripheral to the true tall-grass prairie zone. One of the main recommendations in the final report from the TGPCP was the establishment of a 1000 ha preserve in this area (Joyce 1989).

CRITICAL WILDLIFE HABITAT PROGRAM

In 1989, the TGPCP became part of a new initiative called the Critical Wildlife Habitat Program (CWHP). This program is the result of a five-year agreement between WHC, the DNR, Manitoba Habitat Heritage Corporation, WWF, and the MNS. All parties contribute financially to the program and are represented on a Steering Committee which guides the direction of the program. The DNR administers the various program components which include management, extension, stewardship, and acquisition. Tall-grass prairie is only one of the areas covered by this program which deals with critical wildlife habitat in all of agro-Manitoba. The program has produced a management manual for prairie grasslands and also initiated an inventory of mixed grass prairie as well as continuing the tall-grass prairie inventory. Under the program, $35,000 per year has been allotted to the acquisition of tall-grass prairie and in the first three years of the program 350 ha were purchased.

PRAIRIE PATRONS PROGRAM

In late 1989, the MNS initiated a new fund raising venture, called the Prairie Patrons Program (PPP), to raise additional funds for tall-grass prairie acquisition. Under this program, Prairie Patrons donate $50 towards the purchase of one acre of prairie. Patrons receive a tax receipt and an honourary certificate issued in their name. Once a prairie site has been purchased, patrons are invited to the official opening of the prairie and are also notified of field trips to the area. To date, over $40,000 in donations have been received through the program. Additional funding from the Nature Conservancy of Canada and two matching grants from the Province of Manitoba's Special Conservation Fund have allowed for the acquisition of three prairies totalling 260 ha.

TALL-GRASS PRAIRIE PRESERVE

The tall-grass prairie preserve is in southeastern Manitoba between the towns of Tolstoi and Gardenton. Although this area occurs in the sparsely wooded grasslands adjacent to the historic tall-grass prairie zone, it nevertheless contains some of the best tall-grass prairie remaining in the province. The size of the preserve was increased to allow for the inclusion of a second area which is approximately 10 km north of the original proposed preserve. This second area was included because it is the only known location in Canada for the Western Prairie Fringed Orchid (*Platanthera praeclara*) and because it contains some excellent examples of oak savannah. Other rare orchids found within the preserve area include the endangered Small White Lady's-slipper (*Cypripedium candidum*) and the Great Plains Ladies-tresses (*Spiranthes magnicamporum*). Purchase of land for the preserve has been ongoing through the CWHP and the PPP which have collectively acquired a total of 610 ha. It is anticipated that all available land in the preserve area will be purchased by 1994. Although some of the land will remain in private hands, the CWHP hopes to use land owner agreements to help preserve the integrity of the preserve.

The area around Tolstoi and Gardenton contains many fine examples of the cultural heritage of the predominantly Ukrainian settlers that homesteaded there. St. Michael's Church, the oldest permanent Ukrainian Church in Canada is adjacent to the preserve and a Ukrainian Museum is located in the town of Gardenton. These and other historical features provide an excellent opportunity to establish a preserve that could highlight both the natural and cultural history of the area. The CWHP is currently in the process of establishing a local advisory committee, to ensure that local concerns are represented, as well as drafting a management plan for the preserve area and a long-term management agreement. Hopefully, cooperative efforts can ensure that the proposed preserve becomes a reality, not just for the short-term but for many years and many generations to come.

LITERATURE CITED

Joyce, J. 1989. Tall-Grass Prairie Conservation Project Final Report. Unpublished.

Joyce, J. and J.P. Morgan. 1989. Manitoba's tall-grass prairie conservation project. Pp. 71-74 *In*: Proceedings of the Eleventh North American Prairie Conference. (Bragg, T. and J. Stubbendieck, eds.). University of Nebraska, Lincoln, Nebraska.

HOLISTIC STEWARDSHIP OF PRAIRIE FRAGMENTS

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INTRODUCTION

Given the fragmented state of the prairies, a primary concern is how small protected areas can be managed most effectively to achieve a representative and ecologically viable network of prairie ecosystems. Current thinking in protected areas stewardship advocates the need for a holistic approach which better integrates protected areas into local communities and landscapes. This paper describes holistic management, provides a rationale for its use, and summarizes steps to achieving it. A small protected area is broadly defined here as a site, less than 1000 hectares, officially reserved for the conservation of nature. This definition encompasses everything from national parks to private lands and excludes campgrounds, picnic areas, parkways, and historic sites with no nature conservation objectives.

Value of Small Protected Areas

While it is generally recognized that bigger is better when it comes to protected area size (McNeely and Thorsell 1991, Schonewald-Cox 1983, di Castri and Robertson 1982, Sargent and Brande 1976, Diamond 1975) the current state of the prairies leaves little choice—all that remains are fragments of a once vast ecosystem. However, regardless of size, fragments can make important contributions towards achieving the goals of the Prairie Conservation Action Plan. The value of small protected areas, grouped here into three functions, are worth re-affirming to guide management actions.

Function 1. Reduction of Habitat Isolation Caused by Fragmentation

Habitat fragmentation has been identified as a leading cause of species loss and ecosystem function disruption, resulting in deterioration of ecological viability (Saunders et al. 1991, Reid and Miller 1989, Wilcove et al. 1986, Harris 1984, Mader 1984, Whitecomb et al. 1981). Small protected areas, although fragmented themselves, have the potential to reduce the negative impacts of fragmentation of larger tracks of wildland. Through effective reserve design and management, these ecosystem remnants can function as transition (buffer) zones, conservation corridors, and/or migratory stopover points (Reid and Miller 1989, Webb 1987, Noss 1987, Soulé and Simberloff 1986, Harris 1984). Thus, small protected areas can function as living stepping stones that bridge the gap between large isolated natural areas.

Function 2. Conservation of Biodiversity

Although it is preferable to protect large tracts of wildlands, the preservation of biodiversity does not always require extensive areas. For example, a wild perennial species of maize (all other forms of maize are annuals) which could save farmers several hundred million dollars a year, was discovered growing on a mere four hectares of land (Fisher 1982). Simberloff and Gotelli (1984) and Saunders et al. (1991) indicate that small protected areas can be used to maximize the variety of habitat types conserved, provide multiple evolutionary opportunities, preserve taxa of highly restricted ranges, and protect breeding/nesting areas. Together these functions contribute to the conservation of biodiversity on both local and regional scales.

Function 3. Enhancement of Pro-conservation Attitudes

Establishing and maintaining a network of ecologically viable protected areas is largely dependent on a strong constituency of supporters. Small protected areas provide opportunities for nature related recreation, research, education, and employment. Through these opportunities, small protected areas can become catalyst sites for fostering positive attitudes toward conservation efforts (Cole 1983, Sheail 1976). This is an especially important role for urban protected areas since urban populations wield significant political and economic power yet tend to be largely alienated from the natural world (Lusigi 1988).

CURRENT THINKING IN PROTECTED AREA STEWARDSHIP

Based on the current thinking in protected areas stewardship, if the above conservation values of small protected areas are to be maximized, a holistic systems approach to protected areas management is essential (Machlis and Tichnell 1985, Ugalde 1989, Lusigi 1988, Agee and Johnson 1988, McNeely 1989, Canadian Environmental Advisory Council [CEAC] 1991). A holistic or ecosystem management approach is similar to the "zone of cooperation" approach embodied by the biosphere reserve concept which recognizes the need to integrate conservation lands into the regional socioeconomic and ecological situation (di Castri and Robertson 1982). It is externally oriented and addresses political, economic, and cultural factors in addition to biological ones both within and outside the protected area boundaries. The underlying philosophy of holistic stewardship is that the long-term survival of protected areas is dependent upon the understanding and support of communities living within or near protected areas. This support can be gained through partnerships with landowners, research institutes, and other resource management agencies; through active public participation in establishment and management of protected areas; and through mechanisms which allow local communities to benefit both socially and economically from the existence of protected areas (Einsiedel in press, Ugalde 1989). The rationale for holistic stewardship of protected areas is evident from studies in landscape ecology, human ecology, and empirical data on commonly reported threats to ecological viability.

RATIONALE FOR HOLISTIC STEWARDSHIP

Insights from Landscape and Human Ecology

Research in landscape ecology (Zonneveld and Forman 1990, Noss 1987) and human ecology (Machlis and Tichnell 1985) indicate that protected areas are systems functioning within a larger regional system of landscape patterns, processes, and land uses. The defining characteristic of landscape ecology is that the landscape can only be understood by viewing it as a whole. Thus, the land is seen as a complex interaction of open, dynamic entities rather than a collection of isolated, static objects. Understanding the spatial and temporal interconnections within the landscape mosaic is fundamental to this holistic perspective.

Applying this holistic systems approach to the protected area, one then sees that the protected area is not a self-contained unit. Rather it is an incomplete system, "embedded in a wider regional ecosystem and is influenced by the population, organization, technology and environment that surround and interact with it" (Machlis and Tichnell 1985:32). When protected areas are managed in isolation from the regional ecosystem context, there can be negative social, economic, and ecological reactions. For example, protected areas managed as islands separate from society may be viewed as "locked-up resources." Another common perception is that parks are "distant, pretty places for tourists, scientists, and biologists" and that "conservation (is) a movement to halt development" (Ugalde 1989). Holistic management can help to change these harmful perceptions by integrating protected areas with the "needs and aspirations of society" (CEAC 1991). In addition to socio-economic implications of isolation, there are ecological impacts. Studies in landscape ecology suggest that integrity and continuity of ecological processes are dependent upon the size, shape, and connectedness of habitats within the landscape matrix. Fragmentation of contiguous landscapes results in both loss of habitat and isolation of habitats with severe consequences on ecological viability of the remaining fragments (for a comprehensive review of fragmentation see Saunders et al. 1991). A holistic management approach is needed to re-connect habitat patches and to re-connect people with natural places.

The need to manage protected areas holistically is furthered emphasized by taking a closer look at the protected area as a human ecosystem. A useful conceptual model developed by Wright and Machlis (1984) identifies the subsystems within a protected area (air, water, soil, vegetation, fauna, cultural resources, visitors, and support infrastructure), the processes connecting these internal subsystems, and the linkages between the protected area and the larger regional ecosystem. The model demonstrates that protected areas are complex systems which require complex, holistic management approaches. Dealing with a single species or subsystem in isolation from the others is likely to cause problems. The complexity also demands a team approach to management. No longer can one person effectively manage protected areas by being a technical specialist in one or even several disciplines. The complexity of protected area ecosystems and their dependency on the regional ecosystem in which they function, requires a diversely knowledgeable person who has the ability to lead a team of players from all sectors of society. From this model it also is apparent that humans are a significant part of the protected area ecosystem, therefore social and cultural factors such as population demographics; economic and political policies; and the needs and aspirations of local communities, need to be incorporated into establishment and management plans. Lastly, and perhaps most importantly, this conceptual framework shows that protected areas are open, dynamic systems. The political boundaries are, of course, artificial and rarely correspond to ecological boundaries. What happens outside the boundary, whether it be pollution, industrial development, or protection of critical habitats hy local landowners, will certainly influence the protected area's health and long-term sustainability. External influences are of particular importance to the ecological viability of small protected areas. For example, Saunders et al. (1991) indicated that small ecosystems tend to be externally driven and Odum (1986) stated that the smaller the ecosystem the more sensitive it is to external forces. And in the words of Reed Noss (1987:5), "smaller reserves with larger perimeter-area ratios have proportionately greater management problems resulting from interactions with the surrounding landscape and its human and non-human inhabitants." Thus, the need to have a landscape perspective, to be cognizant of the ecological and socio-economic systems in which the small protected areas functions, and to work cooperatively with local communities and governments is magnified for stewards of small protected areas.

Threats to Long-term Ecological Viability

Further evidence supporting the need for integrative management was shown in a recent University of Alberta study. To set training objectives and develop a curriculum for the Protected Areas Management Certificate Program, we conducted a survey of managers in the United States and Canada to obtain answers to the following three questions: What are manager's perceptions of current training needs? What are the common threats to long-term ecological viability? What are the common areas of management inadequacy in existing programs? The response from over 450 managers representing all categories of protected areas suggest that a holistic management approach which breaks down the artificial barriers between protected areas and surrounding cultural and natural communities is necessary to achieve excellence in management (for details see Brown et al. 1992, Einsiedel and Brown 1992). Specifically, the most common threats to long-term ecological viability for small protected areas were: 1) lack of funding and staff, 2) human encroachment, 3) industrial and agriculture activities, 4) human abuse and misuse of the protected area, and 5) exotic species invasion. These results suggest that the most serious block to developing au ecologically viable system of protected areas is the widespread lack of society's appreciation, understanding, and support of these sites and natural areas in general. This is evident from the external nature of threats to ecological viability. Of significance is the widespread under-allocation of financial and human resources given to protected area agencies which in turn has many negative ripple effects in terms of their ability to properly protect, inventory, monitor, and promote protected areas. Overall, the threats to long-term ecological viability provide empirical evidence for the importance of focusing management efforts beyond the reserve boundaries.

HOLISTIC MANAGEMENT - TURNING OBSTACLES INTO OPPORTUNITIES

The complexity of protected areas and severe threats to their long-term survival may seem overwhelming. However, through cooperation, networking, and innovation, these obstacles can become exciting opportunities to involve people in protected areas stewardship and thereby develop a widespread land ethic. For instance, to overcome the shortages in financial and human resources, new programs to encourage the participation of local people and organizatious are emerging. The following is a guideline to developing a holistic management program adapted from an International Union for the Conservation of Nature (IUCN) management effectiveness checklist (IUCN 1986):

1. Systems plan (including land acquisition, corridor and land-use zoning).

2. Cultural and ecological information base.

3. Measurable management objectives.

4. Written, implemented, and monitored management plan.

5. Pro-active research program with research opportunities for universities, colleges, etc.

6. Public relations and communications program.

7. Mechanisms to actively involve local communities in site planning and management such as volunteer programs, local advisory committees, and public environmental reviews.

8. Program to establish and demonstrate real benefits to local people such as employment opportunities, eco-tourism, erosion control, etc.

9. Visitor services and interpretation program.

10. Conservation education program including school programs and community out-reach activities.

11. Innovative fund raising program.

12. Active management program to restore dysfunctional ecological processes and mitigate external threats.

13. Landowner contact program.

14. Ongoing staff training.

CONCLUSION

Through a holistic, landscape perspective it becomes obvious that protected areas are strongly interconnected and dependent on the social, economic, and ecological systems in which they function. It is also evident that protected areas alone will not be sufficient to achieve conservation goals. Nowhere is this more evident than the prairies where the greater portion of remaining prairie habitats is under private ownership. Here the need to work cooperatively with landowners and all the players in the prairie landscape mosaic is imperative. A holistic stewardship approach sets the atmosphere for achieving these urgent goals.

No specific action steps or recommendations were generated during the workshop on the stewardship of small protected areas. However, it was evident from the discussions that there is a strong need for practitioners to share common management challenges, solutions, and ideas, especially pertaining to specific management techniques. The University of Alberta's Protected Areas Management Program is looking at the possibility of assisting in organizing a network among stewards which could meet this need. Anyone interested in such a network and has skills, ideas, or funding to offer is encouraged to contact Lesley Brown at the above address.

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LITERATURE CITED

Agee, J.K. and. D.R Johnson (eds). 1988. Ecosystem management for parks and wilderness. University of Washington Press, Seattle, pp. 3-14.

Brown, L.P., A.E. Einsiedel, Jr. and J.R. Butler. 1992. Some training priorities: A survey of American and Canadian protected areas managers. Paper presented at the IVth World Congress on National Parks and Protected Areas, Caracus, Venezuela, February 1992.

Canadian Environmental Advisory Council. 1991. A protected areas vision for Canada. Minister of Supply and Services Canada, Ottawa.

Cole, L. 1983. Urban nature conservation. Pp. 267-268 *In*: Conservation in perspective (A. Warren and F.B. Goldsmith, eds.), John Wiley & Sons Ltd.

Diamond, J.M. 1975. The island dilemma: lessons of modern biogeographic studies for the design of natural reserves. Biological Conservation 7:129-146.

di Castri, F. and J. Robertson. 1982. The Biosphere Reserve concept: 10 years after. Parks 6(4):1-6.

Einsiedel, A.A., Jr. Participatory project management. Faculty of Extension, University of Alberta, Edmonton, Canada. In press.

Einsiedel, A.A., Jr. and L.P. Brown. 1992. Is scientific expertise enough to be effective in parks management? Pp.223-228 *In*: Science and the management of protected areas (J.H. Willison, S. Bondrup-Nielsen, C. Drysdale, T.B. Herman, N.W. Munro and T.L. Pollock, eds.). Proceedings of an international conference held at Acadia University, Nova Scotia, Canada. May 1991.

Fisher A.C. 1982. Economic analysis and extinction of species. Department of Energy and Resources, University of California, Berkley.

Harris, L.D. 1984. The fragmented forest. The University of Chicago Press, Chicago.

International Union for Conservation of Nature and Natural Resources. 1986. Managing protected areas in the tropics. IUCN, Gland, Switzerland.

Lusigi, W.J. 1988. The new resources manager. Pp. 42-51 *In*: For the conservation of earth. (Vance Martin, ed.), International Wilderness Leadership Foundation, Fulcrum, Inc. Golden, Colorado.

Machlis G.E. and D.N. Tichnell. 1985. The state of the world's parks: An international assessment for resource management, policy and research. Westview Press, Colorado.

Mader, H.J. 1984. Animal habitat isolation by roads and agricultural fields. Biological Conservation 29:81-96.

McNeely, J.A. 1989. Protected areas and human ecology: How national parks can contribute for sustaining societies of the twenty-first century. Pp.150-157 *In*: Conservation for the twenty-first century, (D. Western and M.C. Pearl, eds.), Oxford University Press., New York.

McNeely, J.A. and J. Thorsell. 1991. Guidelines for preparing protected area system plans. Parks 2(2):4-8.

Noss, R.F. 1987. Protecting natural areas in fragmented landscapes. Natural Areas Journal 7(1):2-13.

Odum, E.P. 1986. Introductory review: Perspective of ecosystem theory and application. Pp. 1-11 *In*: Ecosystem theory and application. (N. Polunin, ed.). John Wiley and Sons Ltd.

Reid W.V. and K.R. Miller. 1989. Keeping options alive: The scientific basis for conserving biodiversity. World Resources Institute, Washington, DC.

Sargent, F.O., and J.H. Brande. 1976. Classifying and evaluating unique natural areas for planning purposes. Journal of Soil and Water Conservation 31:113-116.

Saunders D.A., R.J. Hobbs and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: A review. Conservation Biology 5(1):18-34.

Schonewald-Cox, C.M. 1983. Guidelines to management: a beginning attempt. Pp. 414-445 *In*: Genetics and Conservation: a reference for managing wild animal and plant populations. Schonewald-Cox et al. (eds.). The Benjamin/Cummings Publishing Co. Inc., Meulo Park, California.

Sheail, J. 1976. Nature in trust: The history of nature conservation in Britain. Blackie and Sons Ltd. London.

Simberloff, D. and N. Gotelli. 1984. Effects of insularization on plant species richness in the prairie-forest ecotone. Biological Conservation. 29:27-46

Soulé, M.E. and D. Simberloff. 1986. What do genetics and ecology tell us about the design of nature reserves? Biological Conservation. 35:19-32.

Ugalde, A.F. 1989. An optimal parks system. Pp. 145-149 *In*: Conservation for the twenty-first century (D. Western and M.C. Pearl. eds.), Oxford University Press., New York.

Webb, C. 1987. Reserves for Nature. Environmental Council of Alberta, ECA 88-PA/CS-S1. Environmental Council of Alberta, Edmonton.

Whitecomb, R.F., C.S. Robbins, J.F. Lynch, B.L. Whitcomb, M.K. Klimkiewics and D. Bystrak. 1981. Effects of forest fragmentation on avifauna of the eastern deciduous forest. Pp.125-205 *In*: Forest island dynamics in man-dominated landscapes (R.L. Burgess and D.M. Sharpe, eds.). Springer-Verlag, New York.

Wilcove, D.S., C.H. Mclelland and A.P. Dobson. 1986. Habitat fragmentation in the temperate zone. Pp.237-256 *In*: Conservation biology: The science of scarcity and diversity (M.E. Soulé, ed.). Sinauer Associates, Sunderland, Massachusetts.

Wright, R.G., and G.E. Machlis. 1984. Models for park management: A prospectus. Cooperative Parks Studies Unit Report CPSU/UI SB85-1. University of Idaho, Moscow.

Zonneveld, I.S. and R.T. Forman (eds.). 1990. Changing landscapes: An ecological perspective. Springer-Verlag, New York.

CASE STUDY: LIVING PRAIRIE MUSEUM

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The Living Prairie Museum is a forty acre preserve consisting of 32 acres of endangered tall grass prairie. It is one of the City of Winnipeg's urban natural area parks. Urban natural areas have three purposes: 1) site preservation; 2) education of the public; and 3) recreation compatible with its preservation.

HISTORY

This tall grass prairie site was originally identified through the International Biological Programme Survey of 1968 (J. Shay, pers. comm.). After three years of lobbying between various citizens groups and the former City of St. James, one sixth of the original 150 acres was preserved in April of 1971. In 1974, the prairie park became part of the newly unified City of Winnipeg. In 1975, the present Interpretive Centre was built, in 1976, staff were hired and the first interpretative programs began. In 1981, an additional eight acres was added to the preserve.

INTERPRETIVE PROGRAM

The current interpretation program involves education and general public components.

Interpretation for the general public begins operation in April with the blooming of the Prairie Crocus (*Anemone patens*), Manitoba's floral emblem. From this annual event the centre is open weekends until the end of June, daily during July and August and again on weekends in September. Displays, slide programs, a self-guiding trail system, guided walks with naturalists, and workshops components comprise the program for tourists and the general public.

The environmental education program offers half-day programs based on the Manitoba Science Curriculum involving topic-specific orientation and interpretive walks with naturalists spring through fall. During the winter season an off-site program is offered to schools and special groups on a variety of environmental subjects.

INITIAL MANAGEMENT

The Living Prairie Museum exists as an island in an urban sea of housing, streets, industrial buildings, and schools. Initial management priorities included periodic burning, control of Canada Thistle (*Cirsium arvense*), and restoring a damaged site on the preserve.

The Living Prairie had several disturbed areas which have allowed for the establishment of alien species such as Brome Grass (*Bromus inermis*) and Canada Thistle. The largest area, of two to three acres, was damaged in the seventies during construction of adjacent apartment buildings. An early solution was to set up a restoration project. The seed source for the plant species was Wisconsin because local seed sources were nonexistent. Now it is considered unacceptable to grow seeds more than three hundred miles from their place of origin. Quite strangely because of this restoration plot the Living Prairie Museum has Compass Plants (*Silphium lacinatum*) and Rosinweed (*S. integrifolium*) which originated from the upper midwestern United States. They are not a threat to the integrity of the preserve. They have not adapted well to the short growing season and drier conditions in southern Manitoba.

Prior to 1986, the controlled burns tended to be conducted opportunistically by Parks and Recreation maintenance personnel. The burns were not specifically timed for any particular management objectives. As a result over time the percentage of shrub cover had increased, and certain native prairie species were felt to be receding in abundance.

CURRENT MANAGEMENT

In the mid '80s a new approach at managing the preserve was taken. A steering committee of professionals was put together for advice on management of this preserve. A literature search was conducted to gather information relevant to management of this unique tall grass prairie. The following objectives were defined: 1) control invading successional woody plant species; 2) decrease exotic or alien plant species; 3) enhance native prairie species; 4) organize or re-establish a monitoring system to analyze plant species change over time; and 5) determine the best management tools to meet the above objectives.

The invading shrubs were determined to be Wolf Willow (*Elaeagnus commutata*), Trembling Aspen (*Populus tremuloides*), Western Snowberry (*Symphoricarpus occidentalis*), and to a lesser extent Caragana (*Caragana arborescens*) which was spreading from an old remnant farmyard.

Invading alien herbaceous plant species included Canada Thistle, White Sweet Clover (*Melilotus alba*), Alfalfa (*Medicago sativa*), and Brome Grass.

Based on the current information available for the targeted species a managed late spring burn program was considered to be optimum in controlling all of the unwanted target plants. Managed burns would also be conducted on a more scientific basis. Wind speed, temperature, humidity, barometric pressure, and fuel loading were among the factors taken into account before conducting a controlled burn.

The 1981 burn study, which had been discontinued, was reinstated in 1986. Data was collected annually on the changing conditions of the species diversity and composition of the tall grass prairie preserve.

The 1977 Restoration Plot with its imported plant species was adopted as a tool for education and interpretation purposes. A separate trail loop was mown to the site. Interpretation of the plot was included on tours and in self-guiding trail brochures.

Additional alien species were removed by hand-pulling through the use of "fine option" volunteers (who were working off traffic fines) and by the naturalist staff. Species which were hand-pulled included Sweet Clover, Canada Thistle, Wild Asparagus (*Asparagus officinalis*), and Alfalfa. Hand-pulling of Sweet Clover and Canada Thistle was the most successful and a substantial reduction has occurred on the preserve since pulling was initiated.

In 1989, management of the woody successional species was assisted by labour intensive hand application of herbicide to a single Wolf Willow clone which expanded out of control. Chemical control was the only reasonable method of returning that particular area of the preserve back into tall grass prairie because the size of the clone had become so large. This clone was not eliminated but rather contained.

WHAT ARE THE END RESULTS?

The first five years of this revised management approach appeared to result in the following: a decrease in non-native cool season grasses such as *Poa* species; enhancemeut of warm season grasses; a decrease in aliens such as Sweet Clover and Canada Thistle; and decrease in monotypic Wolf Willow and Aspen clones on the preserves

FUTURE MANAGEMENT OBJECTIVES

Three primary objectives have been set up: to analyze the burn study data to yield more concrete figures on species composition, species diversity, percentage cover of grass, forbs, and woody species, and change or shift in species composition if any. On other tall grass prairie preserves it has been found that small preserves are frequently subject to composition change because the management techniques cannot or will not duplicate the historical controls of fire and grazing by Plains Bison (*Bison bison*). The primary alien plant invader is now Brome Grass. Options for its control will be analyzed. Girdling of Trembling Aspen has been added to control suckering in some areas and continued hand-pulling by volunteers of Sweet Clover, Canada Thistle, and Wild Asparagus will be carried out.

CONCLUSION

The Living Prairie Museum is a unique mesic prairie remnant which was classified as an "A" quality prairie by the Tall Grass Prairie Project. It has specific site problems which have to be addressed individually. In addition, in a time of decreasing budgets, creative ways of getting the job done are necessary.

HELPING ENDANGERED SPECIES: COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA AND RECOVERY OF NATIONALLY ENDANGERED WILDLIFE. IS THIS THE BEST THAT WE CAN DO?

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INTRODUCTION

After a 13 year effort, 213 Canadian species have been placed on the COSEWIC (Committee on the Status of Endangered Wildlife in Canada) list. Although 20 to 30 reports may be reviewed each year, the rate at which species are added to the list in Canada does not reflect the rate at which they become endangered. On the other hand, the RENEW (Recovery of Nationally Endangered Wildlife) program was established in 1988 to develop a national strategy for the recovery of endangered species. So far, 23 recovery teams have been assembled for the 37 eligible species and only three recovery plans have been approved, two in 1986 prior to RENEW and the third has yet to be printed. This should be measured against a background estimate of 8,643 Canadian terrestrial, freshwater, and marine species of plants, animals, and microorganisms that are endangered or already lost (Mosquin and McAllister 1991). The purpose of this paper is to present a critical evaluation of these programs and suggest new ways to tackle the challenge of biodiversity conservation in Canada.

COSEWIC, 13 YEARS OF LISTING ENDANGERED SPECIES

COSEWIC is responsible for preparing an official national endangered species list, which is viewed with a great deal of respect and credibility. It is important that this credibility be maintained and that both the public and governments understand (and consequently support) listing of species by COSEWIC. As long as this is the case, species on the COSEWIC list enjoy special consideration, even though they may have absolutely no legal protection.

It is important that COSEWIC not fulfil a mere cataloguing function, as appears to be the case when the committee listed as extirpated the Illinois Tick-trefoil (*Desmodium illinoensis*), a plant which is known from Canada from a single specimen collected more than 100 years ago. Rather, COSEWIC's activities should advance action on endangered species. Consequently, priority of status designation should be given to those species for which something can and should be done before their situation deteriorates further. We could, for example, concentrate our efforts on keystone and critical-link species, those often anonymous species that are considered to play a vital role in ecosystem function (Westman 1985 *in* Westman 1990) such as invertebrate and plant species. Concerns about priority of listing have been expressed by some COSEWIC sub-committee chairmen, particularly by Dr. Erich Haber who is looking at some 500 plant species that are candidates for review. Such situations indicate that it is perhaps time to start using a habitat approach, i.e., designate habitats (rather than, or in addition to, species) so that, if protected or rehabilitated, the future of all species in those habitats is safeguarded. In this respect, the ecosystem approach to wildlife conservation suggested by the Ontario Wildlife Working Group (1991) must be commended.

Identification and preservation of critical habitats (old-growth forests, marshes as well as wintering, nesting, or calving grounds) or biodiversity hotspots is another approach that should be considered at the national level. Alfonso (1991) describes how Geographic Information Systems (GIS) can be used to select areas rich in species or endemics for protection. Anderson (1984a, 1984b) demonstrated that hotspots for major groups of organisms do not differ substantially. The recent establishment of Conservation Data Centres by the Nature Conservancy and the GIS data base of rare Canadian plants currently being compiled by Dr. Haber should definitely contribute to identifying these critical sites.

The approach of the Québec Endangered Species Act to that problem is worth mentioning. The act provides for the establishment of a list of species susceptible of being designated as vulnerable or threatened and for which protective measures may be taken to ensure their survival (even prior to their inclusion on the official list).

As COSEWIC does its work it continues to run into "new" situations, which must be dealt with in a logical, consistent manner. Currently, there are problems with listing populations, with listing species that reach the northern limit of their distribution in southern Canada, and with the creeping in of political considerations.

Listing of Populations

The Plains Grizzly Bear (*Ursus arctos*) is a case in point. In April 1991, it was listed as extirpated. One must question the point of listing this animal at all, as no one is really sure whether there ever was a Plains Grizzly from the taxonomic point of view. Thus, we must assume we are dealing with part of the geographical range of the species. In that case, listing the Plains Grizzly goes against COSEWIC's own definition of an extirpated species: any indigenous species of fauna or flora no longer known to exist in the wild in Canada but occurring elsewhere.

There are other considerations. Does it make sense to list a species as extirpated from part of its range? On the surface, this seems reasonable, even desirable, but problems arise if this is followed to its logical conclusion. Almost every Canadian species no longer occupies its entire original range. Should we then list species such as the Timber Wolf (*Canis lupus*) which no longer occurs over much of southern Canada? What about the Wolverine (*Gulo gulo*), American Marten (*Martes americana*), Fisher (*M. pennanti*), etc.? If we take this even further, we could end up in absurdities, such as listing very common species, for example, deer absent from cities. Also, almost every species now on the COSEWIC list would have to be revisited and listed as extirpated over parts of its range. In addition, how will COSEWIC deal with any of the currently listed populations if they should disappear?

Division of species into geographic populations (not necessarily coincident with taxonomic differences) certainly serves to draw attention to the plight of species in trouble in certain areas and encourages maintenance of populations over their entire recent ranges, which is very important. Moreover, it is very valuable for management purposes. At the same time, it gives rise to the problems discussed above. In addition, it confuses the public. Further it can be responsible for the addition of a large number of entries to the endangered species list, giving the impression that COSEWIC is being alarmist.

There does not seem to be an easy solution to this dilemma. It may be advisable to avoid, as much as possible, listing populations as separate entries and restrict listing to taxonomic groups only, down to the subspecific level. In that case, it would be necessary to find other means of drawing attention to the plight of populations. Perhaps a separate list would be useful. The danger is that this second list might not be taken as seriously as the "main" list, or be largely ignored.

Northern Distribution Limits

There are a number of species with most of their distribution range occurring in the United States and barely reaching into southern Canada. Many of these get listed as vulnerable, as their populations in Canada are so small that they can easily disappear. Some get listed in more serious categories. Yet, some of these species occur over a wide range in the United States, and some are common there. Moreover, population fluctuations at range limits are a normal occurrence. By placing such species on the list, COSEWIC gives them the same importance as it does to species that are truly in trouble over most or all of their range.

For example, in April 1991, the Illinois Tick-trefoil was added to the list as extirpated. Yet, it is known to have occurred in Canada from only one collection made in 1888 in southern Ontario, and has never been seen since. In this case, the species has a fairly large distribution in the United States, but has never been abundant there. Nevertheless, it does not deserve the same importance as the Black-footed Ferret (*Mustela nigripes*) or Swift Fox (*Vulpes velox*). The case of the Illinois Tick-trefoil is probably the most extreme in that it is probably a case of sporadic range extension. However, a number of other species are listed because their ranges extend only into small portions of Canada. It might be more practical, and certainly more sensible, to look at the health of species on an ecosystem basis, rather than taking political boundaries into consideration.

COSEWIC is in a bit of a bind on this one, however, as its mandate is to deal with the status of species in Canada, irrespective of their status in the United States. However, there is no doubt that other species are much more deserving of attention. There is also a danger that COSEWIC may be taken less seriously if it lists species at the northern limit of their ranges in the same categories as species that are truly in trouble in Canada. Nevertheless it is the responsibility of each nation to preserve its biota, whatever their condition elsewhere. In some cases, it is the United States population which is of greater concern. We could, 1) rate species differently or 2) fund preferentially those species in the greatest overall danger.

Political Considerations

A feature of COSEWIC is that range jurisdictions for any given species have a special say. This can be both positive and negative. Range jurisdictions often have a better understanding of what is happening and why, so their judgement on a matter can be very valuable. However, politics tend to creep in.

For example, the Polar Bear (*Ursus maritimus*) had been up for consideration for several consecutive years. Every time, COSEWIC believed that it should be listed but the range jurisdiction successfully argued for deferral. In 1991, even the range jurisdiction agreed that from the purely biological point of view, the Polar Bear should be listed, but still argued against listing for political reasons.

Another example of political intervention was the Sharp-tailed Sparrow (*Ammodramus caudacutus*) which was deferred only because the range jurisdiction, Québec in this case, asked that it not be considered because no Québec representative would attend the COSEWIC meeting as a result of the failure of the Meech Lake constitutional accord.

If COSEWIC is to do a proper job, hard scientific facts must be the sole basis upon which status is allocated. Theoretically, and to a large extent practically, this is the case now. However, it is not always the case. Consequently, a way must be found to eliminate political intervention. In this respect, we should pay attention to the suggestions made by Mace and Lande (1991) concerning the status attribution process.

RENEW—ACTING TO PRESERVE BIODIVERSITY

Being on the COSEWIC list does not offer a species any formal protection or confer any legal status. A few provinces have endangered species acts, but there is no consistency, and most provinces still do not have any endangered species legislation at all. However, because COSEWIC is respected and has credibility, species on the list often receive special consideration from governments, conservation organizations, and even from industry. As a result, environmental impact assessments take endangered species into consideration and recommend mitigation measures to maintain populations. Most efforts, however, are not as well organized and coordinated, and thus are not always as effective as they could be.

In 1988, the establishment of RENEW was seen as a good way to have all agencies, organizations, and individuals work together to help species at risk.

Unfortunately, RENEW does not deal with plants, invertebrates, fish, or marine mammals. It deals only with terrestrial vertebrates (birds, mammals, amphibians, and reptiles) that have been listed by COSEWIC as threatened, endangered, or extirpated. This means that even within these taxonomic groups, RENEW does not deal with species in the vulnerable category. So, whereas COSEWIC is restrictive, RENEW is even more so; it is committed to addressing only 37 of the 213 listed species (17%). Canada's marine fauna is given low priority even though we have the longest coastline of any nation, and possess 6.5 million km^2 within our 200 mile fishing zone and our Arctic Sector (versus 10 million km^2 of terrestrial habitat).

Although the creation of RENEW is a positive step, progress has been very slow. In 1989, RENEW made the commitment to have, by 1991, recovery teams in place for all 26 species eligible at that time. Recovery plans for 12 species were to be approved by the fall of 1990, for 12 more species by a year later, and the remaining species by the fall of 1992. However, we are still struggling with the creation of recovery teams and preparation and approval of recovery plans. By February 1992, the number of eligible species had increased to 37. Recovery teams have been assembled for 23 of these. To that date, only three plans had been approved: Whooping Crane (*Grus americana*), Peregrine Falcon (*Falco peregrinus anatum*), and Piping Plover (*Charadrius melodus*). Another seven plans have been submitted but are not yet approved, and 12 other draft plans are in preparation. Obviously, the process is painfully slow. A great deal of time and money is required for this species-by-species approach. The implementation of the habitat approach would be much more effective, especially for species groupings requiring similar conditions. Such areas for plants could be easily located using Dr. Haber's GIS system.

One way to speed up this process is through greater inter-agency cooperation and development of new partnerships. For example, RENEW should establish closer working relationships with Forestry Canada, Fisheries and Oceans Canada, the Canadian Council on Ecological Areas and the Canadian Museum of Nature (the latter has one of the nation's largest biodiversity data bases, BIODIV). The establishment of conservation networks has recently been suggested in order to protect and manage the large natural areas needed to sustain key species as well as the integrity of entire ecosystems (Salwasser et al. 1987). Recovery teams should identify and integrate in their recovery plans nongovernment organizations (NGOs) and institutions such as zoos, aquariums, botanical gardens, conservation organizations, science museums, interpretation centres, colleges, and universities, that could help them fulfil their mandate at the local level. Government authorities that oversee conservation efforts should formally recognize the financial, scientific, and/or technical contributions of private corporations, NGOs, and private or public institutions to recovery plans by signing memoranda of agreement. These memoranda of agreement would not only help to ensure long-lasting cooperation between organizations (Salwasser et al. 1987) but could foster the contribution of other, previously unknown partners to the immense task of preserving biodiversity (Prescott and Hutchins 1991).

Provincial and territorial jurisdictions are key players in the protection of biodiversity. Through the recent endorsement of "A Wildlife Policy for Canada" they have recognized the maintenance and reestablishment of biodiversity as one of their major goals. They must now increase their contribution to RENEW and ensure that sufficient funding is available. In addition, ways must be found to deal with the 83% of COSEWIC species not currently eligible under the RENEW program, and those yet to be listed by COSEWIC.

OTHER INITIATIVES

Although COSEWIC and RENEW are important when dealing with endangered species, they are, by no means, the sole players. Over the years, much has been done without these two committees. Whooping Cranes would probably be extinct by now if it hadn't been for the work done by interested people and governments before either COSEWIC or RENEW ever existed. Vancouver Island Marmots (*Marmota vancouverensis*) have also received help prior to the existence of RENEW. Captive breeding and subsequent reintroduction efforts have been initiated by dedicated people and government for the Swift Fox and Peregrine Falcon. But perhaps the biggest success story is that of the American White Pelican (*Pelecanus erythrorhynchos*). This species was listed in 1978 by COSEWIC as threatened. Even though no RENEW recovery plan was ever written for the species, Canada Life (whose corporate logo is the American White Pelican) and World Wildlife Fund (WWF) Canada combined forces and did some tremendous work. As a result, the pelican was removed from the list in 1987, the only species to have ever been delisted.

One might ask: Is any attention being paid to non-RENEW species? And what about non-COSEWIC species—the lowly invertebrates and non-vascular plants? Fortunately there are people interested in all these taxonomic groups.

The St. Lawrence Beluga (*Delphinapterus leucas*) in Québec, the Right Whale (*Balaena glacialis*) off the east coast, and the Sea Otter (*Enhydra lutris*) in British Columbia, all of which are marine mammals, have their champions. Along the west coast, Sea Otters were once numerous but the last individual was shot in 1929. Between 1969 and 1972 (again, before both COSEWIC and RENEW), scientists from the Pacific Biological Station released 89 otters from Alaska in an area off the west coast of Vancouver Island. Now there are over 300 Sea Otters in British Columbia's waters. A group of Québec scientists and citizens are studying problems faced by Belugas in the extremely polluted St. Lawrence River. Aided by Québec conservation groups, the St. Lawrence National Institute of Ecotoxicology, WWF, Canada and the Canadian Nature Federation (CNF), they are seeking to establish a marine park to protect Beluga habitat. Without waiting for RENEW to extend its mandate to include fish and marine mammals, the Department of Fisheries and Oceans (DFO), as the agency responsible for these species, has begun to work on their recovery. As the recovery plan format is working quite well, DFO is basing its efforts on the RENEW pattern.

The invertebrates are a lot less fortunate. They are not valuable as game species, and most are not well loved by the general public. However, even here, some taxonomic groups have found champions. Butterflies, perhaps because many are quite showy, have been the centre of considerable attention.

The Monarch Butterfly (*Danaus plexippus*), though in no danger in Canada, is vulnerable on its wintering grounds. Consequently, Canadians, including the CNF, have been working with Mexicans to ensure that important wintering habitat is preserved. A major travelling exhibit on this fascinating species is currently being produced by the Canadian Museum of Nature, the CNF, and a Mexican conservation group called Monarca A.C. Another example closer to home is that of the Karner Blue (*Lycaeides melissa samuelis*). A CNF affiliate, the Lambton Field Naturalists, raised money to buy critical habitat of this species in southern Ontario. Other examples of local groups, and even individuals, helping endangered species can be found. In many cases, these efforts are effective because the people involved are very close to their subjects and know exactly what is required.

However, a chronic lack of funding for such projects can be crippling, or render efforts useless. In recognition of this fact, Environment Canada and WWF Canada joined forces and contributed $1 million each to create the Endangered Species Recovery Fund. This fund, administered by WWF Canada, is used to assist in practical, applied work towards the recovery of endangered plants and animals native to Canada. It is not limited to species covered by COSEWIC or RENEW. Priority of funding depends on the national significance of projects, based on the degree of threat, taxonomic uniqueness, geographic distribution, and potential for recovery. Applicants for funds must normally be affiliated with a NGO, however, direct funding of individuals or companies may be considered in some cases. As of February 1992, the Endangered Species Recovery Fund has funded more than 76 projects across Canada. Although this program has been successful, there is a need to streamline the allocation of funds and develop a proactive manner to identify priority projects.

CONCLUSION

It is evident that a great deal is being done for endangered species, but this does not mean that we can relax. In fact, there is a lot of room for improvement, and many species still await attention. In Canada, while we are lucky enough not to be losing species at this time, we must remain vigilant and ensure that the less popular groups are also looked after so that all Canadian wildlife—all wild species—continue to exist. We must also work very hard to prevent species from becoming endangered. In other words, prevention is still far better than cure.

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LITERATURE CITED

Alfonso, N. 1991. An Equal-area Grid Map for GIS: A Tool for Biodiversity Conservation and Biogeography. Canadian Biodiversity 1(1):30-32.

Anderson, S. 1984a. Areography of North American Fishes, Amphibians, and Reptiles. American Museum Novitates, Number 2802, pp. 1-16, figs. 1-9, tables 1,2.

Anderson, S. 1984b. Geographic Ranges of North American Birds. American Museum Novitates, Number 2785, pp. 1-17, figs. 1-9.

Mace, G.M. and R. Lande. 1991. Assessing Extinction Threats: Toward a Reevaluation of IUCN Threatened Species Categories. Conservation Biology, 5(2):148-157.

Mosquin, T. and D.E. McAllister. 1991. Canadian biodiversity: A census and appraisal. Canadian Centre for Biodiversity, Canadian Museum of Nature, Ottawa. Unpublished Report, 77 p.

Ontario Wildlife Working Group. 1991. Looking Ahead: A Wild Life Strategy for Ontario. Ontario Ministry of Natural Resources. 172 p.

Prescott, J. and M. Hutchins. 1991. Joining Efforts for the Preservation of Biodiversity. Trans. 56th N. Am. Wildl. & Nat. Res. Conf. Pp. 227-232.

Salwasser, H., C. Schonewald-Cox and R. Baker. 1987. The Role of Interagency Cooperation in Managing for Viable Populations. Pp. 159-173 *In*: Viable Populations for Conservation (M.E. Soulé, ed.). Cambridge University Press, Cambridge, 189 p.

Westman, W.E. 1990. Managing for Biodiversity. BioScience 40(1):26-33.

A PROPOSAL TO INCORPORATE MULTI-SPECIES PROGRAMMING INTO THE NORTH AMERICAN WATERFOWL MANAGEMENT PLAN IN ALBERTA

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PREAMBLE

The North American Waterfowl Management Plan (NAWMP) was signed in 1986 by the governments of Canada and the United States, thereby, agreeing to co-operate in an effort to restore waterfowl populations to the long-term average as exemplified by numbers in the 1970s. The plan encouraged the formation of joint ventures to carry out this ambitious conservation effort. The largest and most important of these was the Prairie Habitat Joint Venture, most commonly referred to as the PHJV.

The PHJV consists of members from the governments of the three prairie provinces, Environment Canada, Agriculture Canada, Ducks Unlimited (DU) Canada, Wildlife Habitat Canada (WHC), and the North American Wildlife Foundation. Responsibility for implementation of the plan was assigned to the Provincial Implementation Groups in each province, resulting in the formation of the Manitoba Habitat Heritage Corporation, Saskatchewan Wetland Conservation Corporation, and the Alberta NAWMP Centre.

The Alberta NAWMP Centre was established to co-ordinate the implementation of the NAWMP in Alberta, on behalf of all its partners: Alberta Forestry, Lands and Wildlife, Canadian Wildlife Service (CWS), DU Canada, Alberta Agriculture, and WHC. The following proposal is an initiative of the Centre and has been approved by the Alberta Board of Directors to whom the Centre is responsible.

INTRODUCTION

Background

Implementation of the NAWMP on a provincial basis began in 1991 with major projects in the prairie, aspen parkland, and peace parkland biomes of Alberta. Responsibility for planning and delivery of the proposed programs rested with the Biome Delivery Groups established for this purpose in each project area. These groups provide the partners with a mechanism for transmitting input and concern directly into the project at the proposal stage. This structure is currently working satisfactorily with respect to waterfowl species but has not been effective in addressing non-waterfowl species concerns and incorporating these concerns into the project proposals. The need, therefore, to formalize a multi-species program was eminent.

Recently, it has become abundantly clear that the United States Fish and Wildlife Service and the Canadian partners are all committed to broadening the scope of NAWMP to include the host of other species associated with wetlands, riparian, and upland habitats as well as those listed as vulnerable, threatened, and endangered. The original 1986 NAWMP documents referenced other species as follows: "Although other wildlife species are not addressed in this plan, many are associated with water and wetlands and must be considered in developing operational plans for habitat preservation." A recent draft of the NAWMP Addendum 1992 states, "The focus of the plan has been broadened to include greater support for wetlands values and species diversity."

"Broadening the scope," it appeared, meant more than just describing or listing species that may derive benefit from NAWMP programs; partner agencies would like to see projects which include development/enhancement/management of habitat for the wide range of species associated with NAWMP in Alberta. This includes expenditures to secure, develop, or manage habitat for these species.

The purpose of this proposal, therefore, is to describe the objectives and the procedures for implementation of a multi-species program for NAWMP in Alberta.

Objectives

The following summarizes the overall objectives for the multi-species program of the NAWMP in Alberta:

1. To identify and review the needs, opportunities, and priorities for migratory and native species with

respect to land management programs as part of NAWMP delivery in Alberta.

2. To determine and document the impact on wildlife species resulting from the full range of ongoing NAWMP land management options.

3. To ensure that delivery of NAWMP activities does not negatively impact other wildlife species.

4. To be aware of the habitat requirements of vulnerable, threatened, or endangered species within the identified NAWMP landscapes and to incorporate these needs into the landscape plans in conjunction with program delivery.

5. To establish an appropriate mechanism for incorporating multi-species land management programming into existing ongoing projects in Alberta. Of particular importance is the need to resolve situations where there are substantial benefits to other species but only moderate or minimal waterfowl benefits.

6. To identify and foster partnerships with other Canadian and United States agencies that may wish to cost share multi-species aspects of the NAWMP program.

7. To heighten the awareness and profile of multi-species benefits of NAWMP programming in Alberta through communications programs.

PROCEDURE

The Alberta NAWMP Centre will assume overall responsibility for directing the multi-species program in Alberta. A team of NAWMP employees will be established to carry out the above stated objectives. Team members will report directly to the Centre. The following outlines structure and responsibilities of the multi-species component in Alberta.

Alberta NAWMP Centre

- Responsible for overall program content, staff assignment and supervision, and budget allocation and approval.

- Responsible for maintaining liaison with Biome Delivery Groups and other partner agencies.

- Responsible for developing terms of reference, appointing members, and maintaining liaison with the NAWMP Multi-Species Technical Advisory Committee.

- Responsible for liaison with the Alberta Board of Directors, the PHJV Advisory Board, and other provincial coordinators.

- Responsible for communications related to the multi-species program.

Multi-Species Team Members

- NAWMP staff knowledgeable in multi-species aspects have been assigned to the team in each of the major biomes although members may be given work outside those biomes. The existing NAWMP Resource Specialists have undergone a reallocation of their work plans to allow more time to be spent on multi-species programming. The following team members will devote a significant percentage of their time to this project: Ernie Ewaschuk, Team Leader, Senior Project Biologist (Edmonton); Reg Arbuckle, NAWMP Resource Specialist (Grande Prairie); Andy Murphy, NAWMP Resource Specialist (Red Deer); Tom Sadler, Wildlife Biologist, NAWMP (Strathmore); Bob Goddard, NAWMP Resource Technician (Lethbridge). The team's mandate is as follows:

- Responsible for identifying status and habitat requirements of non-target species in the current and future landscapes of NAWMP land program delivery.

- Responsible for ensuring the above data are made available to the Biome Delivery Groups for incorporating into the landscape plans.

- Responsible for establishing a process for incorporating multi-species into the landscape plans including: inventory information, approval criteria, and development/enhancement techniques.

- Responsible for establishing and maintaining liaison with Biome Delivery Groups, local and regional naturalist/interest groups, and other related government/non-government agencies.

- Assisting in the development and delivery of the multi-species communications program.

NAWMP Multi-Species Technical Advisory Committee

The main objective of the committee will be to provide technical advice to the Alberta NAWMP Centre with respect to the implementation of the multi-species program in Alberta. The committee will be chaired by the Alberta NAWMP Centre. Membership will consist of individuals knowledgeable in technical aspects of all species associated with NAWMP programming. Other experts or agencies may be called in as required to deal with specific situations or species. The committee will review proposals put forth by the Centre and make recommendations related to the priority and technical aspects of proposals. The committee may recommend projects, provide species priorization and/or identify areas that require research. The committee may recommend funding sources available to assist in the multi-species program.

PROJECTS UNDER WAY OR IN PROPOSAL STAGE

Piping Plover (*Charadrius melodus*) habitat study in relation to the 1991 International Census is currently in progress with funding from Alberta NAWMP Centre. A proposal has been submitted to CWS, to cooperate in gathering census information on shorebird migration and breeding related to large marshes identified in the Alberta plan (NAWMP). Two proposals are underway to secure Piping Plover habitat in east central Alberta, in relation to NAWMP landscape planning. Finally, a proposal is being developed to assess the effects of NAWMP land treatments on non-target wildlife species. The study will compare treated and untreated landscapes.

LANDSCAPE ECOLOGY, ADAPTIVE RESOURCE MANAGEMENT, AND THE NORTH AMERICAN WATERFOWL MANAGEMENT PLAN

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INTRODUCTION - THE AGRICULTURAL ROOTS OF WILDLIFE MANAGEMENT

The science of wildlife management and that of ecology developed historically along different lines (Nudds 1979, 1988). Wildlife science tended toward the study of wild populations of single species with the (often implicit) goal of understanding how to manipulate some of them to achieve greater yields. Definitions of "wildlife management" in recent textbooks evolved little from Leopold's (1933) original: the sustained production of annual crops of wild game (Nudds 1988). Close academic links between wildlife management and agriculture (Table 1) contributed to the notion that, as in agriculture, high-yielding crops of harvestable wildlife could be achieved through the application of improved technology. To be fair, there has been for a long time in wildlife management circles the idea that not to manipulate wildlife constitutes conscious management, and managers are concerned increasingly with non-game wildlife without the goal (explicit or implicit) of producing high yields for harvest (e.g., Capen 1989). Nevertheless, production remains a cornerstone of wildlife management, as does the idea—in some circles—that to achieve it requires intensive, high-material-input (HMI) techniques.

Wildlife managers developed expertise in data acquisition (McCabe 1985: 338) and a "practising knowledge" based on empiricism, but wanting for theoretical frameworks both to guide the collection of data and to interpret it (Fretwell 1972, Sinclair 1991). Conversely, ecological science tended toward explanations for why populations fluctuate and focused greater attention to interactions among species, to communities, and to ecosystems than did wildlife management (Nudds 1992), but it tended also to develop theory wanting for empirical evaluation (Nudds 1979).

Events of the last couple of decades are causing wildlife managers to rethink some of the implicit assumptions about the goals and practices of management (e.g., Capen 1989). For instance, landscape ecology (Naveh and Liebermann 1984, Forman and Godron 1986) and conservation biology (Soulé and

Table 1. The distribution of Canadian and American universities with and without undergraduate programs in agriculture and wildlife biology. The sampling universe for American schools (n = 106) was all private (e.g., University of Washington) and public (e.g., Washington State University) universities listed in Furniss (1973). Information about Canadian schools (n = 48) was obtained from various university calendars. Overall, there is a strong dependence of the presence of wildlife programs on the presence of agricultural programs (χ^2 = 19.6, $p < 0.005$). The effect is significant within countries also (American schools: χ^2 = 13.02, $p < 0.005$; Canadian schools: χ^2 = 10.3, $p < 0.005$). Many schools have neither type of program. Many more have agriculture programs without wildlife biology programs, but the reverse is seldom true; in eight of those 10 cases the "agriculture" program present is one in forestry and silviculture. These data indicate that the influence of agricultural thought on philosophies about wildlife management is likely to run deep in academic curricula.

	Agricultural Program	
Wildlife Program	Present	Absent
Present	34	10
Absent	34	76

Wilcox 1980, Soulé 1986) came of age. Among the goals of landscape ecologists and conservation biologists is greater synergism between "pure" and "applied" research. There is increased attention among wildlife managers to merge theory with practice (Romesburg 1981, Nudds and Morrison 1991) and to manage wildlife by conducting management as experiments (McNab 1983, Sinclair 1991, Walters and Holling 1990). Further, there is growing awareness that some HMI agriculture may undermine the sustainability of agricultural systems (Ehrenfeld 1987, Jackson and Piper 1989). Ironically, although wildlife managers have long vilified intensive agriculture as a cause of habitat destruction, some intensive, HMI-style wildlife management may no more contribute to the long-term sustainability of wildlife than will some intensive farming contribute to the long-term sustainability of agriculture.

In this article, we build a brief history of the demise of the productivity of both agriculture and waterfowl on the Canadian prairies. We outline why there is an opportunity to reverse these declines through cooperation, rather than conflict, between agriculture and wildlife interests, and why the North American Waterfowl Management Plan (NAWMP) became the culmination of activity by proponents who recognized that opportunity. We then briefly contrast two schools of thought about what kind of wildlife management techniques—intensive (i.e., increasing duck production on small tracts of land) or extensive (i.e., affecting broad-scale changes to the landscape)—ought to be used to rebuild declining populations. We follow with a brief review about what is known about the prospects for success by either approach and conclude that, in spite of a great deal of information about ducks, we currently have insufficient knowledge to deem any one approach better than the other for reversing population declines. We finish with a suggestion that managers implement projects in ways that can be evaluated to test among the competing approaches—in effect, to do management by experiment (McNab 1983, Sinclair 1991)—and give the "flavour" of one experimental design that might accomplish that.

DECLINE OF AGRO- AND NATURAL ECONOMIES IN THE PRAIRIES

The prairie ecosystem supports two kinds of economies; the long-term sustainability of both are in jeopardy. Policies to encourage grain production, even on marginal land (Figure 1), made economic sense when Canada was virtually the sole supplier of grains to the

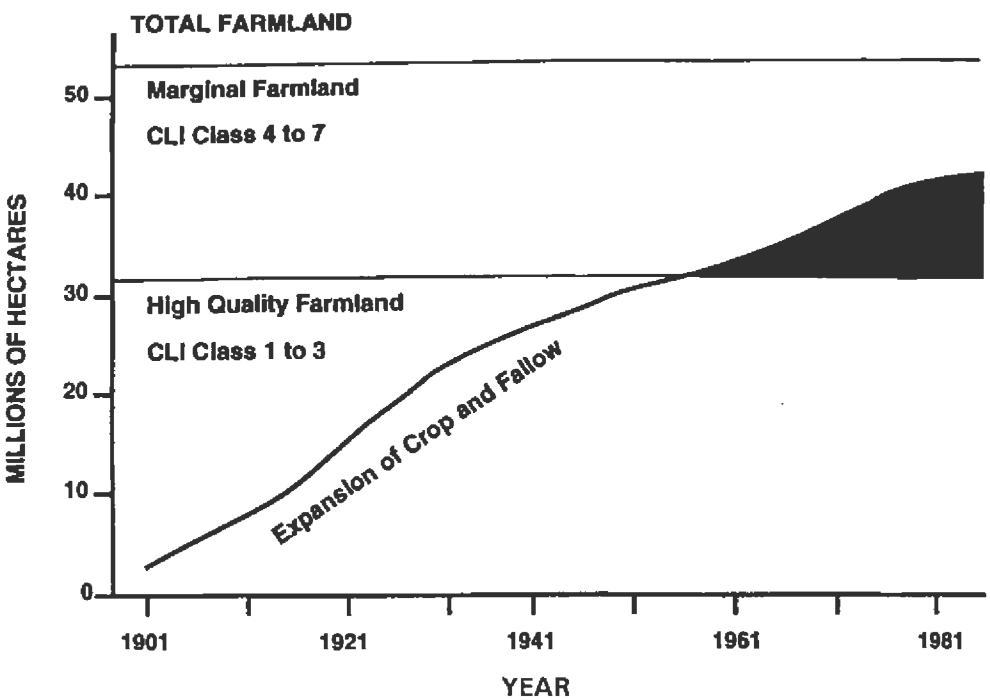

Figure 1. The expansion of "improved" agricultural land in prairie Canada. In many areas, the best quality land was occupied by about the late 1950s; agricultural expansion since has been largely onto marginal, lower-quality land which is more costly to farm (courtesy J.H. Patterson, unpubl. data).

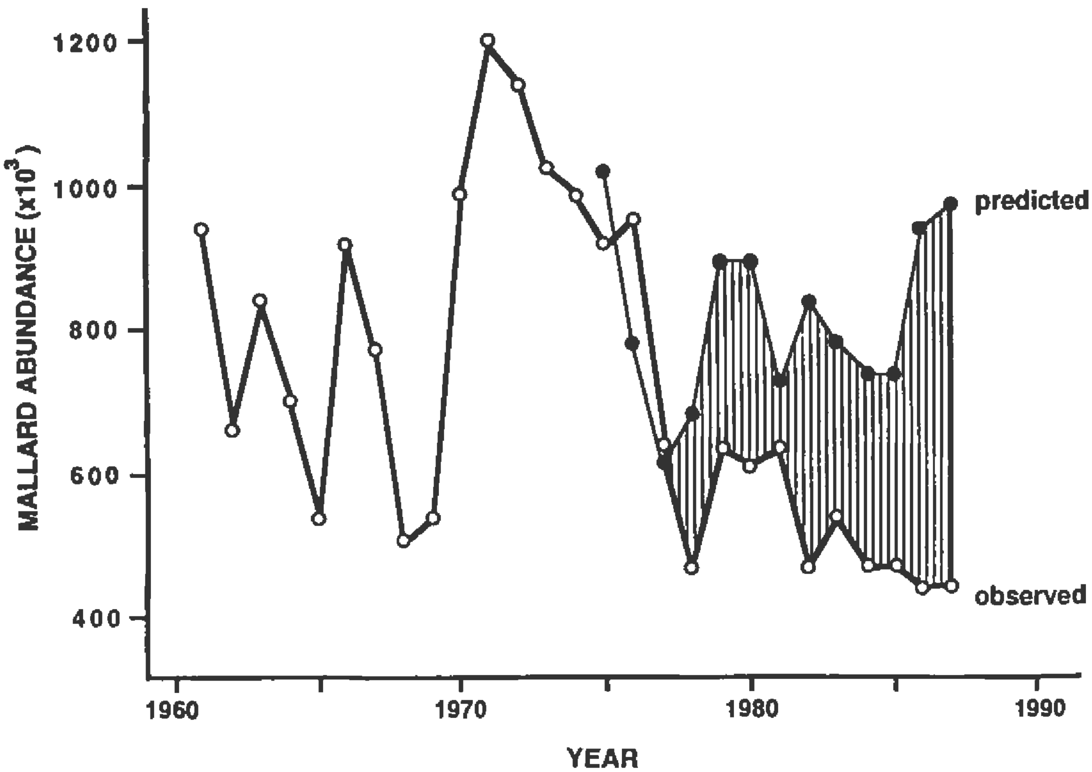

Figure 2. The observed and predicted abundances of Mallards in a part of southeastern Alberta. The predicted abundance is based on the relationship between precipitation and Mallard abundance prior to 1975, when the two fluctuated closely (Bethke and Nudds, in press).

world. However, economic and ecological developments have caused hardship for grain farmers. Former grain customers became self-sufficient and began to compete in world markets, and sustained price wars led to prices for Canadian grain too low to meet rising costs of production. For a time, governments tried to cover the shortfalls but persisted nevertheless with policies that encouraged marginal land conversion to "improved" agricultural land and greater production. Reductions in yields during the dry years of the 1980s exacerbated the problem, so that between 1981 and 1991, the proportion of prairie farmers' incomes supplied by subsidies had increased to as much as 80 percent. Governments have been forced to reduce commodity support subsidies, further increasing economic hardship among prairie grain producers.

Over the same period, wildlife interests documented the decline of the natural economy of the prairies—in some areas, the complete disappearance of some species, and the decline of others. Many of Canada's rare, endangered, and threatened nongame wildlife are in the prairies. Since the mid-1970s, populations of Mallards (*Anas platyrhynchos*) (Johnson and Schaffer 1987), Northern Pintails (*A. acuta*), and Blue-winged Teal (*A. discors*) have declined to levels below even that which existing wetlands can support, or which precipitation levels predict ought to be present (Figure 2; Bethke and Nudds, in press). This is inconsistent with the notion that climate is responsible for the declines in duck populations. Rather, it appears that some anthropic agent, like changes to nesting habitats that decrease breeding success, over-winter mortality, or both are to blame. However, because neither population sizes nor breeding success of Mallards and Northern Pintails in boreal forest (where agriculture is absent but ducks are still hunted) appear to have declined over 30 years, it seems that changes to the prairie landscape (Figure 3) may have been relatively more important than events away from breeding areas as causes of declines of prairie ducks (Nudds and Cole 1991).

THE EMERGENCE OF THE NAWMP

On the assumption that habitat loss was responsible for declines in duck populations, and because there was a "window of opportunity" to affect change to agricultural policy during difficult economic times on

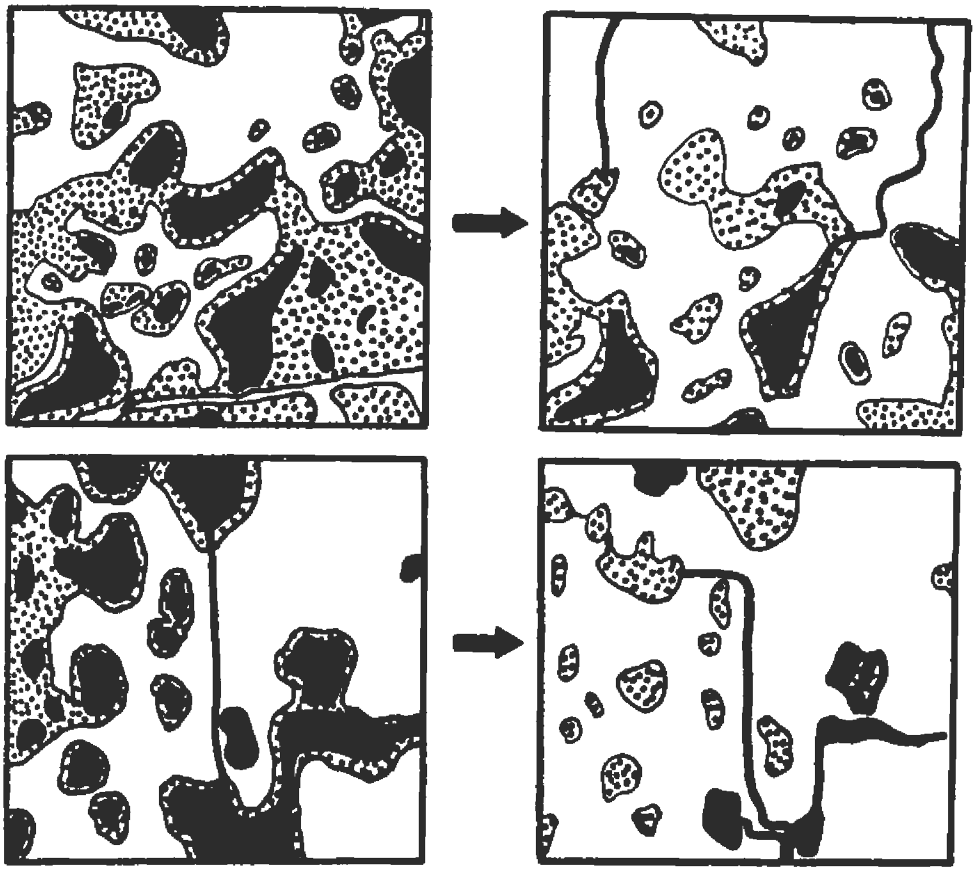

Figure 3. Changes over 10 years on two sections of agricultural land in Saskatchewan aspen parkland. Strippled areas represent natural habitats, dark areas are wetlands, and white areas are cropland (after Adams and Gentle 1978).

the prairies, Canada and the United States initiated NAWMP in 1986. The NAWMP expanded quickly to include proposals to protect and manage wintering grounds as well as breeding grounds, but a principal focus remained that aspect of the plan that dealt with breeding areas in intensively-farmed prairie Canada, the Prairie Habitat Joint Venture.

Some agricultural interests, like Agriculture Canada, contributed early to the plan, realizing the logic to the argument that ducks and grain were dependent on the same requisites. Ducks and grain required water, and some agricultural practices were inefficient at conserving it, ultimately, to the detriment of both. Further, some soil management practices were causing soil losses through wind erosion; and ducks might find adequate nesting habitat if the establishment of permanent cover on erodible soils was encouraged. With grain prices low, recovery of marginal land that was too costly to farm should be possible. Other wildlife would benefit. NAWMP was conceived and sold on the idea that, through a landscape-ecological approach, it might be possible to put both the agro- and natural economies of the prairies back on a sustainable footing.

TWO SCHOOLS ABOUT RESTORING DUCK POPULATIONS: MANAGING FOR DUCKS OR MANAGING FOR LANDSCAPES?

A goal of the NAWMP is to restore duck populations to sizes that will fluctuate near mid-1970s levels (on the assumption that these sizes approximate the long-term averages of extremely variable populations), but another view developed about how to achieve it. Frustration that had developed while wetlands were drained, and marginal land converted to cropland, dampened enthusiasm among some wildlife managers for the notion that cooperation with agriculture, rather than conflict, might lead to recovery of duck populations.

Some argued that the recovery of land in amounts that would matter was impossible, so the alternative to compensate for habitat losses was to manage for increased duck production in remnant parcels of habitat, or to create small, intensively managed parcels for duck production in agricultural landscapes. This view continued the tradition of considering the purpose of research and management on ducks to be "to grow two where only one grew before" (Green et al. 1964: 568). Others viewed intensive management as an interim measure because landscape modification was going to take a long time.

Proponents of both extensive and intensive management accepted that a major factor contributing to duck declines was low hatching rates of nests due to high rates of predation. Habitat alteration is thought to force ducks to nest in small, remnant patches of habitat (Figure 4) where they may be more vulnerable to nest predators (see review by Clark and Nudds 1991). Prairie settlement also brought changes to the composition of predator communities, from those dominated by predators that did not prey extensively on ducks and their nests to those that do (Johnson and Sargeant 1977). Further, proponents of each approach agreed with the implicit assumption that nest survival was an important "bottleneck," and that populations could be augmented by reversing a presumed historical decline in nest success. However, past this general agreement there was little other.

AGRICULTURAL INTENSIFICATION ← **ultimate**

↓

HABITAT FRAGMENTATION
AND
WETLAND DRAINAGE

↓

INCREASED NEST PREDATION ← **proximate**

↓

DECREASED POPULATION SIZE

Figure 4. "Levels of causation" for factors hypothesized to cause declines in prairie ducks.

OVERVIEW OF EVIDENCE ABOUT THE EFFECTIVENESS OF INTENSIVE AND EXTENSIVE MANAGEMENT

The intensive school offered that either removal of nest predators, or deterring them with some combination of plantings of dense nesting cover (DNC) (Duebbert 1969, Duebbert and Kantrud 1974), perhaps also with electric fences (FDNC) (Duebbert and Lokemoen 1980, Lokemoen et al. 1982), would augment nest success. This view assumes that: 1) nest success, in fact, declined over time (Beauchamp et al., submitted manuscript); and 2) increasing it should translate into increased "recruitment," at least to the fall population, while acknowledging that little is known about duckling survival, fledging success, overwinter survival, and homing to natal sites (that is, recruitment to the breeding population; e.g., Anonymous 1987, Cowardin et al. 1988). However, although a recent review of the evidence for a decline in nest success indicates that it has (Beauchamp et al., submitted manuscript), the evidence about the effect of predator fences and/or removals (Greenwood et al. 1990) and DNC plantings (Clark and Nudds 1991) on nest success is equivocal and the effects unpredictable (Beauchamp et al., submitted manuscript).

Proponents of extensive management also proposed that nest predators be deterred through habitat manipulation, but indirectly, and pointed out that trying to affect change in a proximate cause of population declines without affecting the ultimate one (Figure 4), would only be treating the symptoms of the ailment. Management to alleviate nest predation at the proximate level might be (at most) fortuitous or (at best) expensive and ongoing, requiring continuous input of capital and personnel. Proponents of extensive management argued that large-scale restoration of marginal land should enable ducks to disperse nests at low densities which should lower the foraging success of predators. Management focused at the ultimate cause could prove to be a less costly solution in the long run, and might benefit agriculture as well as waterfowl. This could be achieved principally through changes to agricultural policy—in particular, the conversion of commodity-support subsidies to conservation-support subsidies. Finally, proponents of extensive management argued that proponents of intensive management had not realistically considered the long-term costs of intensively rearing ducks, even if it could be shown that the assumptions on which it was predicated were correct and that intensive techniques consistently "work." The NAWMP amounts to a subsidy to produce ducks; its lifetime is projected to be 15 years. At that time, it would disappear, leaving duck populations with no habitat base to sustain them and managers with an infrastructure too costly to support.

Extensive landscape management to affect changes to nest success (and recruitment) is not without its own problems. As outlined above, it is not clear how much of observed declines in breeding populations might be due to events during the breeding season, or to events in areas away from breeding habitats (or both). Further, a recent review by Clark and Nudds (1991) concluded that nest success is not consistently greater on larger areas of habitat. They hypothesized that the degree to which nest success varies with patch size might itself vary inversely with the degree of degradation of agricultural landscapes (Figure 5). Nest success may be lower over all patch sizes in severely degraded landscapes than in moderately degraded landscapes because absence of alternative nest sites, and fewer patches, may concentrate more ducks (resulting in inverse density-dependence in nest success due to crowding) or more predators (resulting in positive density-dependence in nest loss) in and/or around each patch. They concluded that "until the relationships among habitat patch size and duck nesting success are determined empirically, ...debate over tbe relative cost-effectiveness of different waterfowl nesting habitats will remain conjectural" (Clark and Nudds 1991: 538). A controlled experiment, conducted as part-and-parcel of ongoing management programs (McNab 1983, Sinclair 1991, Clark and Nudds 1991), is necessary to decide the relative importance of the confounded factors affecting nest success and recruitment in prairie ducks and allow managers to choose among competing proposals (intensive versus extensive), or an appropriate mix, to augment them.

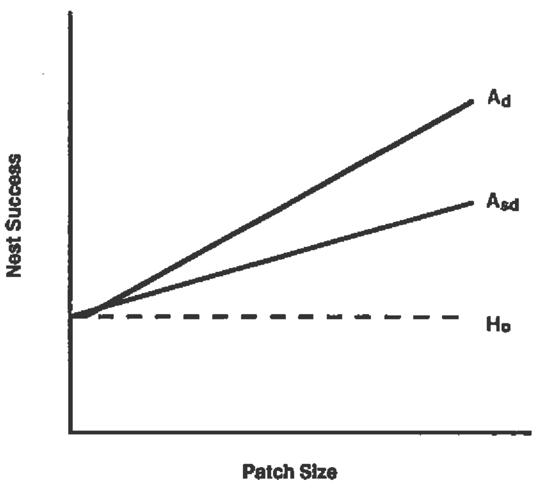

Figure 5. The hypothesized effect of patch size on nest success (proportion of nests that hatch successfully) of ducks in habitat patches. H_o is the relationship predicted by the null hypothesis. A_d is the relationship predicted by the alternate hypothesis in degraded landscapes, and A_{sd} is that predicted for severely degraded landscapes.

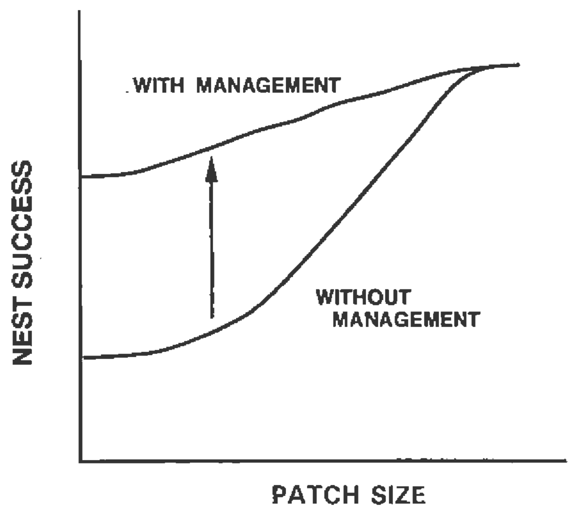

Figure 6. Nest success may vary with patch size naturally. The purpose of predator management is to try to augment nest success on especially small patches.

AN EXPERIMENTAL PROTOCOL TO TEST BETWEEN INTENSIVE AND EXTENSIVE MANAGEMENT TO INCREASE DUCK POPULATIONS

Nest success can vary with the size of the tract of land (patch) upon which it is measured (Clark and Nudds 1991, but see Clark et al. 1991, Higgins et al. 1992) (Figure 6), but it is sometimes high on small tracts (Gatti 1987) with intensive management (e.g., Greenwood et al. 1990). So, increased nesting success might be achieved by either direct, intensive predator management or indirect predator management through extensive landscape management, but there is conflicting evidence for each. From a management perspective, the questions remain: 1) can intensive predator management such as fenced enclosures and dense cover plantings consistently increase nest success or recruitment and, if not, why not?; 2) are intensive management techniques equally effective over a range of patch sizes?; 3) if not, is there some patch size above which no intensive management will return more, in terms of nest success or recruitment, for the investment than extensive landscape management alone?; and 4) which of the intensive (predator management) or extensive (landscape management) options is most cost-effective over the long-term?

The answer to the last question cannot be known until there are answers to the others (Figure 8). To get the answers requires that management be conducted as experiments (MacNab 1983, Walters and Holling 1990). The simplest of such experiments could be designed to be analyzed by regression with a treatment, a control, and patch size as a covariate (Figure 7). Figure 7 shows recruitment to the breeding population (i.e., ducklings that survive to reproduce) plotted against size for each of control (CON) patches and, say, patches of FDNC. Two points need to be made about the figure. First, only linear relationships with positive intercepts are plotted. More realistically, the curves might pass through the origin and be convex downward because, at one extreme, there can't be ducks breeding on zero land and, at the other extreme, there must be some upper limit to recruitment. Because the shapes of the curves do not affect the argument for the need for an experiment, the case with linear relationships is presented for simplicity.

Second, even if high nesting success is achieved among crowded nesting populations on small plots, inverse density dependent processes (lowered growth and survival) among ducklings might mean that no net recruitment occurs to the fall population, let alone the breeding population (Clark and Nudds 1991). So, nest success may not be an appropriate response variable for gauging the efficacy of intensive management designed to increase breeding populations. For simplicity, the experiment is outlined using recruitment as the relevant response variable, though it would be informative to measure other variables at several points in the annual cycle, such as egg success, nest success, and duckling survival, to test if and when density-dependence is manifested (Hill 1984).

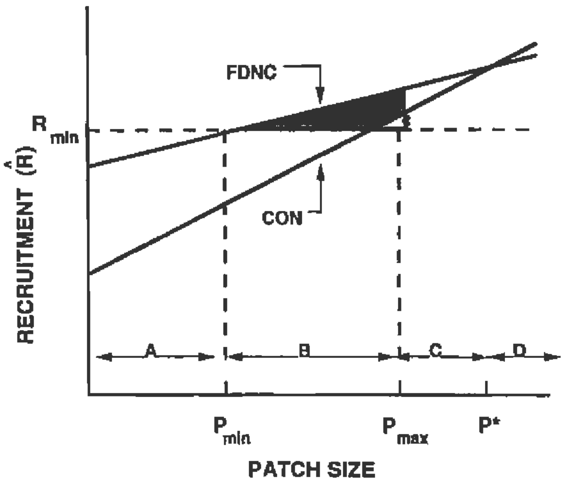

Figure 7. The feasibility of managing predators to increase duck populations depends on whether, and how, recruitment (to the breeding population) from habitat patches of various sizes varies with predator management.

Let R_{min} be the minimum recruitment rate to maintain a breeding population of ducks (Figure 7). The NAWMP requires that this level is exceeded, since the goal is to increase duck populations and not just maintain them. Suppose that R (observed recruitment to the local breeding population) varies with patch size on unmanaged CON patches and can be further increased in FDNC. Whether FDNC is actually better than CON, of course, can be determined by the experiment, as can the exact shape of the curves.

The best management option in the example depicted in Figure 7 depends on the constraints. P_{min} is that patch size below which no intensive predator management pays, nor which is worth acquiring (if the objective is to increase R). In region A, no patch size, even with management, is worth acquiring. If the maximum land parcel available (P_{max}) is smaller than P* (that patch size above which intensive predator management cannot augment recruitment better than that which can be achieved in large, unmanaged patches alone), then the management option ought to be the cheapest alternative within the shaded feasibility region B. For instance, the largest P with FDNC may be too expensive, but at least all combinations of P and FDNC within the shaded region should increase R and the population. Which is the "best buy" will depend on land, material, and labor costs amortized over an appropriate time period. In region C, predator management should still return more than increasing patch size alone, but constraints (P_{max}) on the maximum

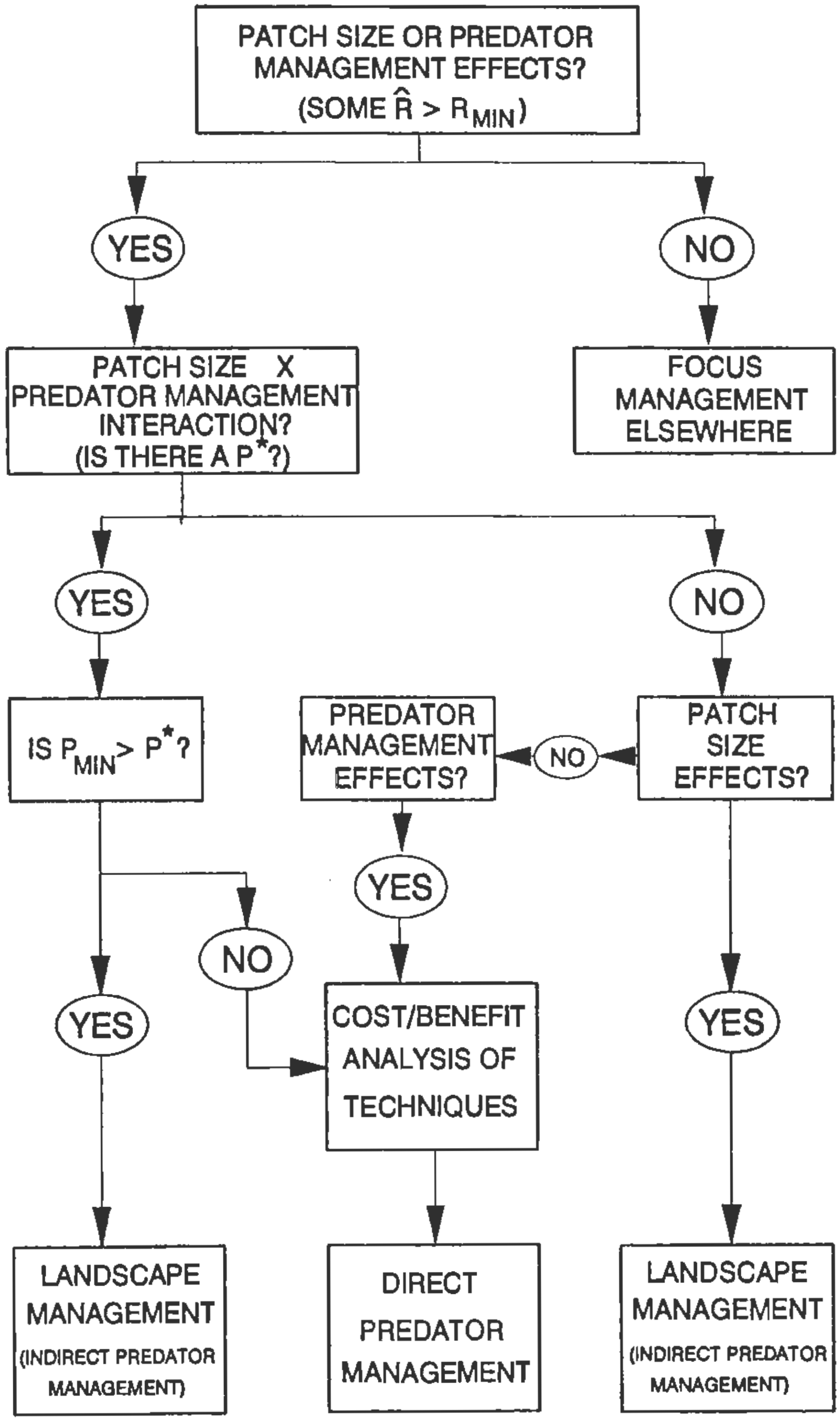

Figure 8. A simple flow diagram to decide among intensive versus extensive alternatives for managing predation on duck nests.

patch size available limits feasibility. Here, no management is possible. If, however, patch size is not constrained by availability or money to sizes below the point at which recruitment is not greater in predator-managed patches than it is in patches with no predator management (P*), then there are diminished returns to investment in intensive predator management (region D). FDNC will never contribute more to recruitment than will a large, unmanaged patch alone; in that case, a landscape ecological approach to management should prove to be better for increasing duck populations. P* is, therefore, an estimate of the minimum patch size needed to reduce the long-term costs of intensive predator management to zero with no reduction in benefits (sustainable duck populations).

If R doesn't vary with P, especially such that it never exceeds R_{min}, neither intensive management nor the landscape option will ever increase population size. Any results like these would imply that conditions on breeding areas do not limit population size and other hypotheses (overwinter mortality, cross-seasonal effects of wintering ground conditions on breeding success) might need to be invoked to account for declines of prairie-nesting ducks (see Nudds and Cole 1991).

The patch sizes employed need not encompass that which gives R, R_{min}, nor P*; as long as R (or some other relevant measure of contribution to a sustainable breeding population) varies with P, sufficient replicates should allow prediction of both P at which R, R_{min}, and P* (Figure 7). Especially to allow prediction beyond the range of patch sizes included in the experiment, there would need to be sufficient replicates (randomly distributed with respect to water regimes and land uses) of treated and control patches over the widest possible range of sizes. Further, the experiment should be replicated in a minimum of two places, because composition of the guild of nest predators differs in different parts of the prairies, and predator management might work better in areas with highly degraded landscapes (like prairie) and landscape management in others, perhaps with less degraded landscapes (like aspen parkland).

MANAGEMENT IMPLICATIONS FOR LANDSCAPE ECOLOGY

Recruitment of ducks to breeding populations is the product of an array of dynamic processes, but many of these are poorly understood and poorly quantified. Until these basic research questions are addressed, the impact of breeding habitat manipulations on duck populations will remain unclear. However, there is no need to curtail management while research proceeds. Instead, we advocate that management proceed by designs that will simultaneously allow for these research questions to be addressed.

In practice, whether management of the landscape is feasible will depend on the willingness of landowners to sell or lease land, and cost. However, our experimental protocol might contribute to resolving unanswered questions about the efficacy of intensive versus extensive management. At any rate, treated as just a simple "thought experiment," this exercise is beneficial if only because it aids in pointing out the complexities involved, and in establishing the severely constrained conditions under which intensive, traditional predator management techniques might be expected to be successful. It also serves to point out that, until questions are answered about whether intensive management is likely to achieve the long-term objective of increasing population size at all (Figure 8), it may be premature to engage in discussions about which of the intensive management techniques is most cost-effective (Lokemoen 1984). The exercise further suggests that a landscape approach may prove more likely to achieve the goals of the NAWMP because such an approach should, at least, address the problem of low duck populations at its source (landscape degradation), thereby treating the ailment rather than merely the symptoms of it.

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LITERATURE CITED

Adams, G.D. and G.C. Gentle. 1978. Spatial changes in waterfowl habitat. Can. Wildl. Serv. Occasional Paper No. 38.

Anonymous. 1987. Small unit management project 1987 annual report. U.S. Fish Wildl. Serv., Northern Prairie Wildlife Research Centre, Jamestown, ND.

Beauchamp, W.D., T.D. Nudds and R.G. Clark. Nest success of prairie ducks: a comparison between unmanaged sites and sites managed for nest predators. J. Wildl. Manage. Submitted manuscript.

Bethke, R.W. and T.D. Nudds. Deficits of duck abundance in the prairie-parklands of Canada. Ecol. Appl. In press.

Capen, D.E. 1989. Political unrest, progressive research and professional education. Personal reflections. Wild. Soc. Bull. 17: 335-337.

Clark, R.G. and T.D. Nudds. 1991. Habitat patch size and duck nesting success: the crucial experiments have not been performed. Wildl. Soc. Bull. 19: 534-543.

Clark, R.G., T.D. Nudds and R.O. Bailey. 1991. Populations and nesting success of upland-nesting ducks in relation to cover establishment. Can. Wildl. Serv. Prog. Notes No. 193.

Cowardin, L.M., D.H. Johnson, T.C. Shaffer and D.W. Sparling. 1988. Applications of a simulation model to decisions in mallard management. U.S. Fish Wildl. Serv. Tech. Rep. 17. Washington, D.C.

Duebbert, H.F. 1969. High nest density and hatching success of ducks on South Dakota CAP land. Trans. N. Amer. Wildl. Conf. 24: 218-229.

Duebbert, H.F. and H.A. Kantrud. 1974. Upland duck nesting related to land use and predator reduction. J. Wildl. Manage. 38: 257-265.

Duebbert, H.F. and J.T. Lokemoen. 1980. High duck nesting success in a predator-reduced environment. J. Wildl. Manage. 44: 428-437.

Ehrenfeld, D. 1987. Implementing the transition to a sustainable agriculture: an opportunity for ecology. Bull. Ecol. Soc. Amer. 68: 5-8.

Forman, R.T.T. and M. Godron. 1986. Landscape Ecology. John Wiley and Sons, New York.

Fretwell, S.D. 1972. Populations in a Seasonal Environment. Princeton Univ. Press, Princeton, NJ.

Furniss, W.T. 1973. American Universities and Colleges. American Council on Education, Washington, D.C.

Gatti, R.C. 1987. Duck production: the Wisconsin picture. Wisc. Dept. Natur. Resour., Bureau of Research, Research Management Findings 1. Madison, WI.

Green, W.E., L.G. MacNamara and F.M. Uhler. 1964. Water off and on. Pp. 557-568 *In*: Waterfowl Tomorrow (J.D. Linduska ed.) U.S. Dept. of the Interior, Washington, D.C.

Greenwood, R.J., P.M. Arnold and B.G. McGuire. 1990. Protecting duck nests from mammalian predators with fences, traps and a toxicant. Wildl. Soc. Bull. 18: 75-82.

Higgins, K.F., L.M. Kirsch, A.T. Klett and H.W. Miller. 1992. Waterfowl production on the Woodworth Station in south-central North Dakota, 1965-1981. USFWS Resource Publ. 180.

Hill, D.A. 1984. Population regulation in the mallard *Anas platyrhynchos*. J. Anim. Ecol. 53: 191-202.

Jackson, W. and J. Piper. 1989. The necessary marriage between ecology and agriculture. Ecology 70: 1591-1593.

Johnson, D.H. and A.B. Sargeant. 1977. Impact of red fox predation on the sex ratio of prairie mallards. U.S. Fish Wildl. Serv. Wildl. Res. Report 6.

Johnson, D.H. and T.L. Schaffer. 1987. Are mallards declining in North America? Wild. Soc. Bull. 15: 340-345.

Leopold, A. 1933. Game management. Charles Scribner's Sons, New York.

Lokemoen, J.T. 1984. Examining economic efficiencies of management practices that enhance waterfowl production. Trans. North Amer. Wildl. Natur. Resour. Conf. 49: 584-607.

Lokemoen, J.T., H.A. Doty, D.E. Sharp and J.E. Neaville. 1982. Electric fences to reduce mammalian predation on waterfowl nests. Wildl. Soc. Bull. 19: 318-323.

McCabe, R.A. 1985. Along the way: a profession and its society in retrospect. Wildl. Soc. Bull. 13: 336-344.

MacNab, J. 1983. Wildlife management as scientific experimentation. Wildl. Soc. Bull. 19: 534-543.

Naveh, Z. and A.S. Liebermann. 1984. Landscape Ecology: Theory and Application. Springer-Verlag, New York.

Nudds, T.D. 1979. Theory in wildlife conservation and management. Trans. North Amer. Wildl. Natur. Resour. Conf. 44: 277-288.

Nudds, T.D. 1988. Effects of technology and economics on the foraging behaviour of modern hunter-gatherer societies. Pp. 23-35 *In*: Knowing the North: Reflections on Tradition, Technology and Science (W.C. Wonders ed.) Occasional Paper 23. Boreal Institute for Northern Studies, Edmonton, Alberta.

Nudds, T.D. 1992. Patterns in breeding waterfowl communities. In press. *In*: Ecology and Management of Breeding Waterfowl (B.D.J. Batt ed.). University of Minnesota Press, Minneapolis, Minnesota.

Nudds, T.D. and R.W. Cole. 1991. Changes in population size and breeding success of boreal forest ducks. J. Wildl. Manage. 55: 569-573.

Nudds, T.D. and M.L. Morrison. 1991. Ten years after "reliable knowledge": are we gaining? J. Wildl. Manage. 55: 757-759.

Romesburg, A.C. 1981. Wildlife science: gaining reliable knowledge. J. Wildl. Manage. 45: 293-313.

Sinclair, A.R.E. 1991. Science and the practice of wildlife management. J. Wildl. Manage. 55: 767-773.

Soulé, M.E. 1986. Conservation Biology: The Science of Scarcity and Diversity. Sinauer Assoc., Sunderland, MS.

Soulé, M.E. and B.A. Wilcox. 1980. Conservation Biology: An Evolutionary-Ecological Approach. Sinauer Assoc., Sunderland, MS.

Walters, C.J. and C.S. Holling. 1990. Large-scale management experiments and learning by doing. Ecology 71: 2060-2068.