BIRDS IN THE BOREAL FOREST

Proceedings of a workshop held March 10-12, 1992 in Prince Albert, Saskatchewan

Workshop sponsored by:
Forestry Canada, Northwest Region
Canadian Wildlife Service
Saskatchewan Department of Natural Resources
Canadian Parks Service, Prince Albert National Park

D.H. Kuhnke, editor

NORTHERN FORESTRY CENTRE
FORESTRY CANADA, NORTHWEST REGION
1993

Proceedings funded by the
Canada-Saskatchewan Partnership Agreement in Forestry

Catalogue No. Fo18-22/1992E
ISBN 0-662-20325-9

Copies of this report are available at no charge from:

Forestry Canada
Northwest Region
Northern Forestry Centre
5320 – 122 Street
Edmonton, Alberta
T6H 3S5

Environment Canada
Canadian Wildlife Service
115 Perimeter Road
Saskatoon, Saskatchewan
S7N 0X4

CANADIAN CATALOGUING IN PUBLICATION DATA

Main entry under title :

Birds in the boreal forest : proceedings of a workshop held March 10–12 in Prince Albert, Saskatchewan

Includes an abstract in French.
Funded by: Canada–Saskatchewan Partnership Agreement in Forestry.
ISBN 0-662-20325-9
DSS cat. no. Fo18-22/1992E

1. Birds, Protection of — Canada, Northern — Congresses. 2. Birds, Protection of — Canada, Western — Congresses. 3. Taiga ecology — Canada, Western — Congresses. 4. Wildlife conservation — Canada, Western — Congresses. 5. Wildlife conservation — Canada, Northern — Congresses. I. Kuhnke, D.H. II. Northern Forestry Centre (Canada).

QH541.5.T3B57 1993 574.5'2642'0971 C93-099450-7

This report has been printed on recycled paper.

PRINTED IN CANADA IMPRIMÉ AU CANADA

Kuhnke, D.H., editor. 1992. *Birds in the boreal forest.* Proceedings of a workshop held March 10-12, 1992, Prince Albert, Saskatchewan. For. Can. Northwest Reg., North. For. Cent., Edmonton, Alberta.

ABSTRACT

The principal objective of the Birds in the Boreal Forest workshop held March 10-12, 1992 in Prince Albert, Saskatchewan was to foster interaction between those concerned with sustaining forests as an industrial resource and those interested in sustaining forests as a habitat for birds and other wildlife. A total of 25 presentations were given in 5 topical sessions: overviews of biodiversity and boreal ecology; state of knowledge of impacts of forest management on birds in the boreal forest; landscape issues - "scaling up" from the stand to the ecosystem; foresters' perspectives on integrated resource management: where are we headed?; and databases and information networks: what do we have and what do we need? Eighty six participants attended the workshop. The workshop launches a new research program on forest bird ecology in western and northern Canada.

RESUME

L'atelier sur les oiseaux de la forêt boréale, qui s'est tenu du 10 au 12 mars 1992 à Prince Albert, en Saskatchewan, visait principalement à favoriser les échanges entre les personnes qui voient les forêts durables comme des ressources industrielles et celles qui les considèrent comme des habitats pour les oiseaux et d'autres espèces fauniques. Au total, 25 exposés ont été présentés dans le cadre de 5 séances thématiques : aperçus de la biodiversité et de l'écologie de la forêt boréale; état des connaissances sur les impacts de l'aménagement forestier sur l'avifaune de la forêt boréale; questions liées au paysage - «mise à l'échelle» du peuplement à l'écosystème; points de vue des forestiers sur la gestion intégrée des ressources : où allons-nous?; et bases de données et réseaux d'information : situation actuelle et besoins futurs. Quatre vingt six délégués ont participé à l'atelier au cours duquel a été lancé un nouveau programme de recherche sur l'écologie des oiseaux forestiers dans l'ouest et le nord du Canada.

FOREWORD

The principal objective of the workshop was to foster interaction between foresters and others concerned with sustaining forests as an industrial resource, and wildlife biologists and other individuals and groups interested in sustaining forests as a habitat for birds and other wildlife. The Integrated Forest Management, Planning and Development program of the Canada-Saskatchewan Partnership Agreement in Forestry served as a catalyst in establishing the workshop. The workshop also launched a new research program on forest bird ecology in western and northern Canada. Eighty six participants attended the workshop.

The focus of the workshop was on migratory songbirds as a component of biological diversity whose vulnerability to habitat management is much less known than for other wildlife such as game species and furbearers. Birds make up 78% of the vertebrate species in the boreal mixedwood forest. Many are vulnerable to habitat degradation on tropical wintering grounds as well as to changes to their breeding habitats.

The 25 papers presented at the workshop are published largely as they were submitted with only technical editing. The opinions of the authors do not necessarily reflect the views of the sponsors of this workshop. The 20-minute discussions between participants and the speaker(s) that followed each presentation are also included.

The workshop was made possible with funding from the following: the Canadian Wildlife Service (Saskatchewan); Prince Albert National Park (the Canadian Parks Service); and Forestry Canada and Saskatchewan Natural Resources under the Canada-Saskatchewan Partnership Agreement in Forestry.

Many individuals contributed to the overall success of the workshop and publication of this proceedings. They are: H. Anderson, V. Begrand, D. Boylen, T. Diamond, O. Naleapea, W. Harris, E. Kowal, D. Kuhnke, B. Laishley, B. Lauterbach, D. Lee, J. Simunkovic and K. Yurach. Technical editing was done by C. Shanks.

Dieter Kuhnke
Editor

CONTENTS

NOTE

SESSION 1

OVERVIEWS

Chair: Tony Diamond
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WORKSHOP OPENING: BIRDS IN THE BOREAL FOREST

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ABSTRACT

Wildlife values incorporated into current forest management plans are usually confined to fur bearers and game animals. Boreal forest is the major habitat for many species of migratory birds, which have different habitat requirements. Of particular concern are the neotropical migrants. They winter in Latin America, where their forest habitat is being destroyed apace. Some of these species are important predators on insect pests such as spruce budworm. Their population declines may constitute a significant threat to maintaining a healthy boreal forest ecosystem.

INTRODUCTION

Welcome to the 'Birds in Boreal Forest' workshop. It gives great pleasure and encouragement to see all the sponsors of this meeting here in these times of fiscal stringency. It is particularly nice to see such a broad cross-section of the communities involved: private-sector forestry, provincial and federal government foresters and biologists, consultants, and academics, from all three prairie provinces and further afield.

The purpose of this workshop is to discuss the problems of managing forests for a group of species whose needs have been under-represented, in most considerations of the habitat needs of forest wildlife.

Wildlife in this context has traditionally meant deer, moose, caribou and marten; that is, big game and fur bearers. The Wildlife Policy for Canada published in 1990 challenges us to consider all non-domestic animals and plants as wildlife.

Canada's Green Plan for the environment includes new programs to improve our ability to manage forests for sustainability of their ecosystems. It includes wildlife and uses wildlife as indicators of the integrity of those systems. As a first step towards this ambitious goal, we are meeting for two and one half days to focus on birds, especially migratory birds. Birds make up nearly 80% of the vertebrate fauna of the mixedwood boreal forest of western and northern Canada. They are vulnerable to habitat modifications in ways that most mammals are not.

NEOTROPICAL MIGRANTS IN BOREAL FOREST

In particular, a large proportion of forest bird species use boreal forest only to breed in, spending the rest of the year on migration or in distant wintering grounds. Many of these 'neotropical migrants' winter in the tropical forests of Central and South America. Here they face widespread conversion of their forest habitats to agricultural land, most of it providing no substitute for the forest to which they are adapted. These species face the double jeopardy of habitat loss at both ends of the migration route for most of their annual cycle. Because of the jeopardy, they must be of particularly urgent concern (Diamond 1991).

Biologists have long been aware that such birds require forest for their survival. The nature and extent of this need varies from species to species, and is unevenly documented. It is also of only passing interest to foresters, who legitimately view forest as a source of timber rather than as a habitat for obscure birds. There is increasing evidence, however, that forests are essential for the survival of forest birds. Birds also play ecological roles within the forest that may be significant in determining the health of the forest.

Birds need the forest, but does the forest also need the birds? A striking example of such inter-dependence concerns birds that are predators of spruce budworms. There are four distinctive species of warbler whose numbers are known to fluctuate in response to budworm outbreaks (Cape May, blackburnian, bay-breasted and Tennessee warblers).

Table 1. Proportions of 1985 winter habitat area predicted to be lost by the year 2000 (from Diamond 1991)

SPECIES		PERCENT HABITAT LOSS
Philadelphia vireo	*Vireo philadelphicus*	83
Orange-crowned warbler	*Vermivora celata*	63
Yellow-bellied flycatcher	*Empidonax flaviventris*	60
Ruby-throated hummingbird	*Archilochus colubris*	59
Palm warbler	*Dendroica palmarum*	53
Northern oriole	*Icterus galbula*	52
Great crested flycatcher	*Myiarchus crinatus*	50
Magnolia warbler	*Dendroica magnolia*	47
Yellow-rumped warbler	*Dendroica coronata*	45
Bay-breasted warbler	*Dendroica castanea*	44
Rose-breasted grosbeak	*Pheucticus ludovicianus*	41
Tennessee warbler	*Vermivora peregrina*	41
Olive-sided flycatcher	*Contopus borealis*	39
Blackburnian warbler	*Dendroica fusca*	34
American redstart	*Setophaga ruticilla*	31
Solitary vireo	*Vireo solitarius*	30
Western wood pewee	*Contopus sorididulus*	29
Canada warbler	*Wilsonia canadensis*	28
Chestnut-sided warbler	*Dendroica pensylvanica*	26
Swainson's thrush	*Catharus ustulatus*	26

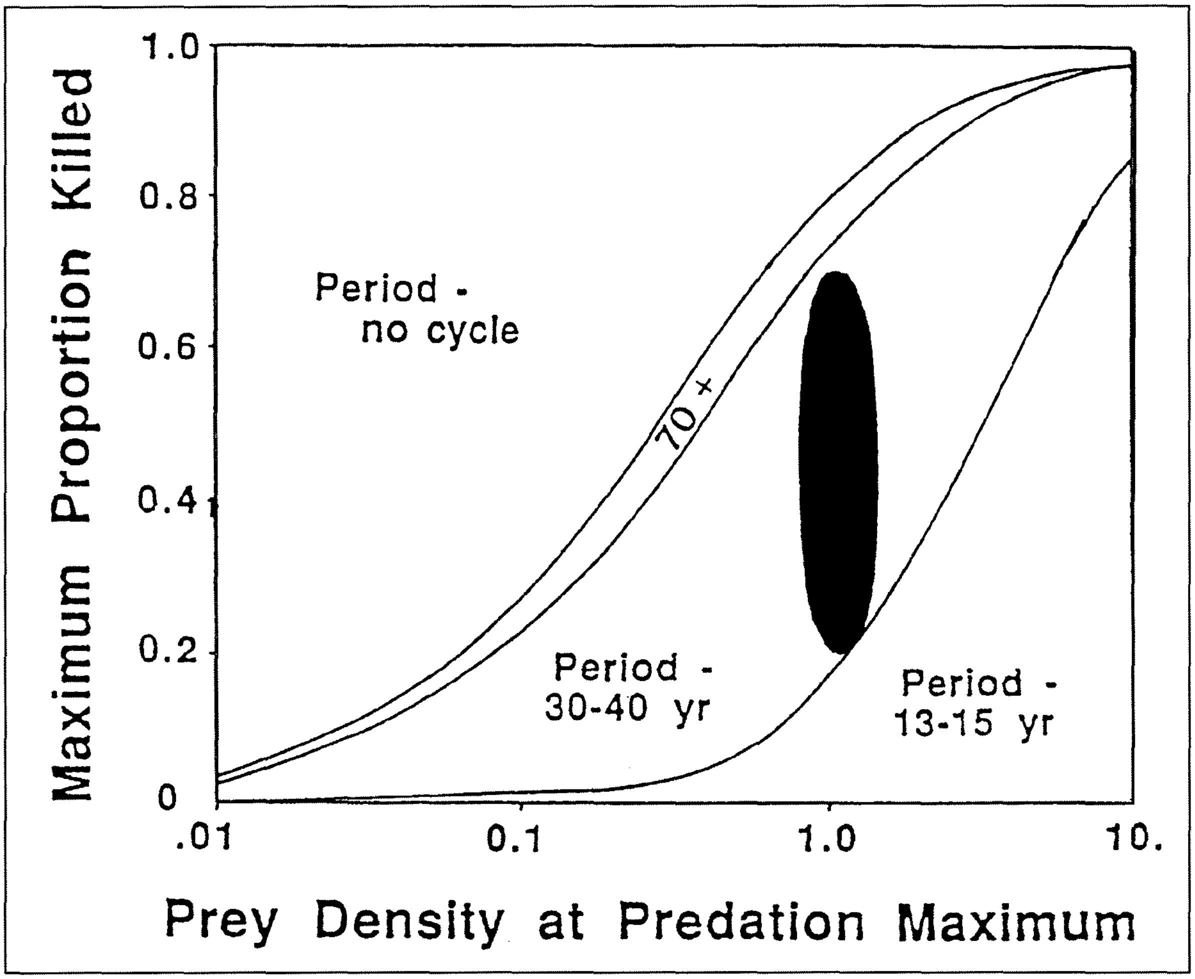

Figure 1. Simulation model of effects on spruce budworm outbreak cycles of variation in predation, for example, by birds (vertical axis) and larval density (horizontal axis). Predation density and larval density interact to produce three classes of cycle periodicity (13-15 yr, 30-40 yr, 70+ yr). The 30-40 yr cycle is maintained over a wide range of predation values (black ellipse). Redrawn from Holling (1988).

Studies in eastern North America have been used to develop computer models of interactions between bird predators of budworm, and the intensity of a budworm outbreak. These show that predation by birds can shift a budworm-outbreak from short cycles to longer ones, and may even hold very long potential cycles at bay indefinitely (Figure 1).

Saskatchewan has not traditionally suffered from spruce budworm outbreaks, so the recent outbreak is both worrying and puzzling (Woodhouse 1992). However, it may be more worrying than puzzling. The Tennessee warbler is a small insectivorous bird that breeds in boreal forest and winters in Central America. The species is also a budworm specialist. It increases its population density and breeding success at times and sites of budworm outbreaks (Crawford *et al.* 1983). In a recent study by the Canadian Wildlife Service, 20 species of neotropical migrant in this region were predicted to lose over

25% of their winter habitat by the year 2000. The Tennessee warbler was predicted to lose over 40% (Diamond 1991).

Data from banders in this region suggest that this species has declined substantially since the 1950s. Table 2 shows the numbers of Tennessee warblers as a proportion of fall migrants banded at two sites in Alberta and two in Saskatchewan in the last four decades. The data are from different decades and are also from different sites. While the data are not conclusive, they are strongly suggestive of a decline. Data supporting the suggested decline in Tennessee warblers come from comparisons between counts of breeding birds in 1973 and 1990/91 (Table 3). These counts are of breeding birds and were made by Canadian Wildlife Service staff on four plots in Weyerhaeuser Canada's lease area near Doré Lake, Saskatchewan. They show trends in the same direction as the data from banding totals of fall migrants, i.e., suggesting a decline in breeding populations of Tennessee warblers.

This relationship between declines in the population of a bird which is known both to be a predator of budworm and a neotropical migrant are likely associated with loss of its tropical winter habitat. Unusual outbreaks of spruce budworm in an area formerly much more densely populated by this bird, is offered as a possible example of ecologically significant interactions between birds and boreal forests.

This example is not proof that the budworm outbreak occurred because Tennessee warblers have declined. However, it is suggestive evidence that in some cases a healthy forest may

Table 2. Proportions of Tennessee warblers in samples of fall migrants banded at four prairie locations over four decades

Location	Nipawin SK	Edmonton AB	Beaverhill AB	Last Mt. Lake SK
Year	1955-60	1957-71	1980-89	1989-91
Total Banded	2636	3455	3513	1935
Tennessee Warblers banded	2031	1957	400	57
% Tennessee warblers	77	57	11	3

Table 3. Number of Tennessee warblers per 100 hectares on four plots surveyed at Doré Lake, Saskatchewan, 1973 and 1990/91

Plot	Habitat type	1973	1990/91
1	Mature birch/poplar forest	80	2
2	Balsam fir forest	49	40
3	Black spruce with alder swales	56	34
4	Young aspen forest	71	20
	Average numbers:	64	24

require a bird population to sustain it. Such relationships will require foresters and biologists to work together to produce long-term management plans, if the boreal forest ecosystem and the birds that are an integral part of that system are to be sustained.

ACKNOWLEDGEMENTS

Alan R. Smith provided the information for Tables 2 and 3, and first drew my attention to the possible connection between spruce budworm outbreaks and Tennessee warbler declines. He and Andrew B. Didiuk were of considerable help in preparing this introduction.

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AN OVERVIEW OF BIODIVERSITY IN FOREST ECOSYSTEMS

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ABSTRACT

Forest ecosystems support relatively high levels of biodiversity because they are tall, have many vertically differentiated niches, and because they have large accumulations of biomass that support a diverse food web. Biodiversity is easy to define conceptually: all forms of life (plants, animals, and microorganisms) at all levels of organization (genes, species, and ecosystems). It is, however, difficult to define biodiversity in a practical management context. Quantitative diversity indices based on richness and evenness can be misleading because an ecosystem with a low level of biodiversity, but a few endangered species, may be a higher conservation priority than a more diverse ecosystem that lacks endangered species. Consequently, the impact of forest management activities on biodiversity should be evaluated at the largest relevant scale. For example, a silvicultural practice that added ten common bird species to the bird community inhabiting a stand, but degraded the stand's habitat quality for a bird species that was rare in that region, could be said to have negatively affected biodiversity.

This paper will focus on forest ecosystems and the buzzword "biodiversity" that has become so popular lately. Many take forests for granted. They are so much a part of our lives that we don't stop and think about what they are. Obviously, a forest ecosystem is an ecosystem dominated by trees. A tree is a large, woody plant. Wood is primarily cellulose and lignin. Thus, a forest is an ecosystem dominated by cellulose and lignin, and that is very important for a number of reasons, the first of which is durability. Wood is a durable material that allows forests to accumulate organic matter through winters. The end result is an enormous accumulation of biomass compared to other ecosystems. Wood is not only durable, but it is also strong. This allows forests to be relatively tall ecosystems compared to other types of ecosystems. These two things together, biomass accumulation and height, allow forests to support a diversity of species. There are many species, such as insects and fungi, that take advantage of this accumulation of biomass. There are many species that take advantage of all the different niches from the dark, damp forest floor to the top of the canopy.

This is the good news. Forests are relatively diverse from a biodiversity standpoint. The bad news is that first, tall things have a tendency to fall down. Second, all this accumulation of biomass attracts agents that want to use it in some way. Examples of these are: fire, wind, insects, and of course, loggers. Speaking from the perspective of the average person, this is bad news. The average person is not sensitive to ecological processes and the fact that disturbance cycles are a natural phenomenon. Think of time as a cycle rather than time as a linear process. Think of patterns of disturbance and succession, therefore as circular. Most people don't accept this very well. All the controversy surrounding the fires in Yellowstone National Park, albeit a fairly natural event, provides some recent evidence. Even among people who understand disturbance regimes controversy always arises when loggers get into the act and become the agent of disturbance.

The balance of this paper will be about biodiversity and some overarching issues of managing diversity in all ecosystems. It is easy to come up with a conceptual definition of biodiversity: simply, all forms of life at all levels of organization. All forms of life, refers to: plants, animals, and microorganisms. All levels of organizations refers to the species level, the genetic level, and the ecosystem level. The species level is the easiest one at which to grasp biodiversity. Species diversity has certainly become a poignant issue, primarily from the perspective of species going extinct. Birds and mammals are only a tiny portion of all biodiversity. Insects represent more than half of all the roughly 1.7 million species that have been described by scientists. Based on the rates at which new insect species are being described (principally from the canopies of tropical rain forests), some people believe that there be thirty million or more species.

Even this figure may be conservative. An analysis plot of body length versus number of species shows a handful of whale species that are in the 5-10 metre long range, a diversity peak between 5 and 10 millimetres, and below 5 mm the number of species decreases again. The decrease below 5 millimetres probably reflects the inadequacy of our taxonomy and suggests that there are many more very small species waiting to be described.

Genetic diversity is most familiar to us as the product of breeding domestic plant and animals. Genetic diversity is not always conspicuous. Scientists at the International Rice Research Institute in the Philippines (late 1960s) set out to try and solve the major problem (grassy stunt virus) facing the world's rice crop at that time. They screened 7 000 different varieties of rice within their collections looking for one that might be resistant to the grassy stunt virus. They found exactly one resistant sample, represented in their collection by two individual kernels of wild rice. They went back to where those kernels of rice had been collected in central India. The rice population with this genetic trait, however, had disappeared in the intervening years. Nevertheless this is a story with a happy ending. They were able to grow out rice plants from these two kernels of rice, and use the genetic information that they contained to solve this major problem.

Conservation biologists talk about genetic diversity in terms of the ability of species to adapt to environmental change. The classic example of this involves moths (*Biston* spp). For many years, these moths existed in a light, cryptic form that blended in with lichens. Occasionally a black individual was found. They didn't last too long, because they were conspicuous and soon eaten by birds. After the advent of industrial pollution the situation changed. Lichens were killed and the trees were covered in soot. The black form became less conspicuous and more common, and the white form became less cryptic and rarer. Recently this story is starting to reverse itself as air pollution control is changing the environment once again. Whether talking about global climate change or any number of environmental changes that are happening, genetic diversity is clearly important.

The third level of organization is ecosystem diversity. What is the importance of maintaining biological diversity at the ecosystem level? There are basically two answers here. One is that some people recognize ecosystems as super-organisms; real biological entities that are far more than a random collection of species. This is becoming a rather old-fashioned view of ecosystems with ecologists emphasizing competition more than synergism. Nevertheless there are certainly some people that hold this view, and there may be some elements of validity to it.

There is a second, much more defensible role for ecosystems in the maintenance of biodiversity. It is most readily explained with a metaphor of coarse filters and fine filters (Figure 1). The basic idea is that by setting aside representative examples of all of the different types of ecosystems that comprise a landscape

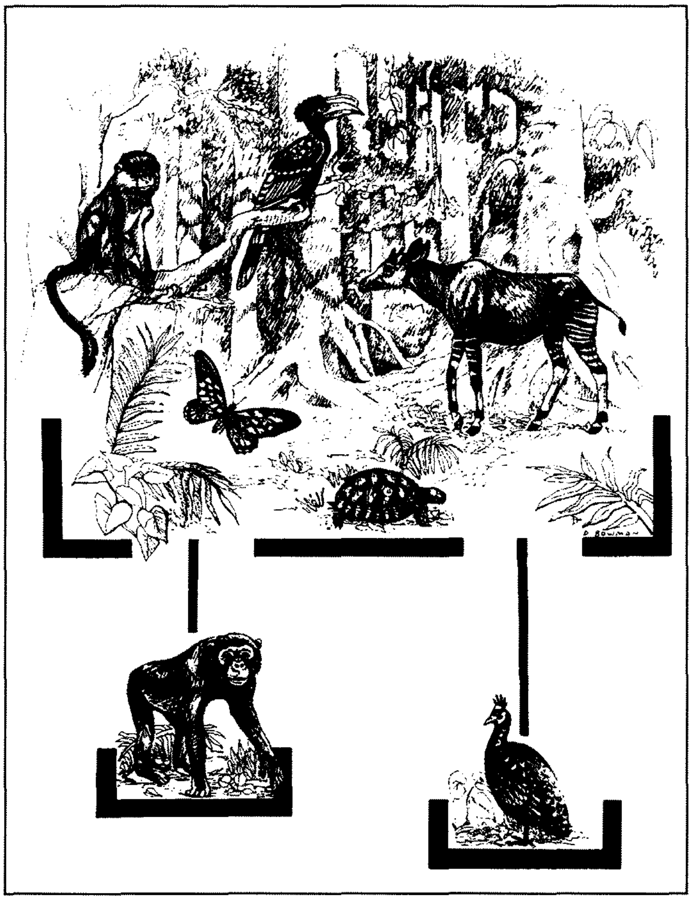

Figure 1. The coarse-filter approach to maintaining biodiversity involves protecting a representative array of ecosystems, such as the Zairois forest pictured here, on the assumption that viable populations of most species will be protected in such a reserve system. It needs to be coupled with a fine-filter approach of individually tailored management plans for some species, particularly those threatened by over-exploitation like the pygmy chimpanzee. Reprinted with permission from "Wildlife, forests, and forestry" by M. Hunter, Prentice-Hall, 1990.

one can protect the vast majority of species. Even insects and microbes that we don't even know exist can be protected, if a good job of protecting a representative array of ecosystems is done.

The coarse-filter approach is coarse because it is working at this gross ecosystem level. It is recognized that some species will fall through the pores of a coarse filter. These will require fine-filter approaches with individually tailored management programs. For example, the pygmy chimpanzee is overharvested because of its use in medical research. Simply saving an example of its habitat, (for example, the Zaire rainforest), would not be sufficient. Protecting chimpanzee populations would also require a specific action.

A conceptual definition of biological diversity (i.e., all forms of life at all levels of organization) is very easy to devise. It is much more difficult to define biodiversity precisely, that is to say quantitatively. There are many quantitative measures of diversity. Let's review them quickly by examining Table 1. Forest A is most diverse because it has the greatest species richness. Richness is only one component of diversity. Forest C is more diverse than Forest B because the number of trees is more evenly distributed among the species. There are many indices for combining these two factors, richness and evenness, to represent quantitatively the diversity among ecosystems. One of the Shannon indices has been shown.

Bringing arguments into a quantitative realm is a long step towards solving complex dilemmas. The following is not one of them. From a biological diversity standpoint it is important to ask which of the three different ecosystems shown in Table 2 is the most important to maintain. Somebody who is totally naive about these lists of species would say it is the forest, because it has the most species. However, if anything is known about these species (one of which is North America's rarest mammal), the prairie ecosystem with its black-footed ferret would be the highest priority.

Table 1. Examples of quantitative measures of diversity

Measures of diversity	Species	Forests A	B	C
			No. of trees	
	Oak	40	120	80
	Pine	30	60	60
	Maple	20	20	60
	Birch	10		
Richness		4	3	3
Evenness		0.92	0.88	0.99
H'		0.56	0.39	0.47

Table 2. An example of the relationship between biological diversity and ecosystem importance

Ecosystem type: Forest	Marsh	Prairie
Red oak	Cattail	Clover
Shagbark hickory	Grasshopper	Prairie dog
Gray squirrel	Marsh wren	Black-footed ferret
White-tailed deer	Raccoon	
Red fox		

How do we get around this problem? On one hand, there are quantitative definitions of biodiversity. On the other hand, they soon prove useless in making decisions about what is important from a biological diversity standpoint. The answer is to focus on the issue of the scale at which diversity occurs. Ecologists often speak of the issue of scale in terms of alpha, beta, and gamma diversity.

Alpha diversity is the diversity within a single ecosystem. For example, the niche separation between a square species of lizard living in the treetops, and a round one that lives on the ground is alpha diversity. Beta diversity is between habitat diversity. For example, if the round and square lizards live in forests and triangular lizards live in grassland this is considered between habitat or beta diversity.

Finally, gamma diversity is diversity at a geographic scale. For example, say that some distance away, perhaps on another island, an elliptical lizard inhabits the forest instead of square and round lizards. Some people would look at this picture and say this grassland habitat only has triangular lizards, so planting trees will result in two species of lizards, square and round, and increase biodiversity. Looking at the situation narrowly, there would be two species of lizards where once there was only one. However, on a larger scale you would have lost the triangular lizards and therefore gone from three lizards to two.

This example may seem like a caricature; let's examine a real one. In the southeastern United States, longleaf pine forest is a type of ecosystem that is becoming quite uncommon. It is being replaced by slash pine and loblolly pine plantations. It used to cover some 25 million hectares in simple, almost monotypic, stands. Some people have tried to make improvements by encouraging a variety of oak species to co-occur with the longleaf pine. That is good for a number of different animal species like, white-tailed deer, bobwhite quail, and turkeys, that use the mast provided by oaks. One of the species that fares well when oak and longleaf pine co-occur is the flying squirrel, again a mast consumer, but here lies the problem. The flying squirrel competes for nest cavities with red-cockaded woodpeckers, an endangered species. Thus, if you encourage oak trees to grow in longleaf pine stands, a much richer suite of species may occur, but you may lose red-cockaded woodpeckers, and compromise biological diversity at a larger scale.

The take-home message is that biological diversity is easy to define conceptually. Starting to actually work with it becomes fairly complicated. Simply using quantitative indices is not going to solve the problem. Think about issues of scale, and ask of the management regime you are imposing: what is its impact on the largest scale that is relevant? Globally endangered species like the red-cockaded woodpecker are far more important than having a few more deer or quail on a given tract of land.

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DISCUSSION

Question by Mr. Diamond: The last point about relating biodiversity to particular threatened and endangered species seems as though you have to approach this on a case-by-case basis. There is never going to be a typical approach to managing the forests for biodiversity. Can you see ways in which that kind of specific information could be made available to forest managers, in a way that they can cope with it on a prescriptive basis?

Response by Mr. Hunter: Yes, at a very simple level. If a species has been identified at a federal or provincial level as an endangered or threatened species, then there is a clear mandate not to do anything that would compromise its habitat. That is simple, and I think most people are doing it reasonably effectively. I think you also need to do two other things. First, you need to ask yourself what are the species that are declining, but have not yet reached the point of being on official lists of endangered species? We should start worrying about their management now, before they fall into that box at the end when suddenly options are constrained, and it is going to be a lot more expensive to deal with them. To whatever extent you can anticipate those problems and solve them up front, everybody is going to be better off (the species, the environmentalists, and the industrial community). The second thing begins with recognizing that we don't know anything about most of the species that are out there. The only practical way to deal with them is with the coarse-filter approach of protecting representative ecosystems.

I don't think it is sufficient to say we have tracts of jack pine, black spruce, aspen in Prince Albert National Park, so the problem is solved. In the State of Maine, we are currently working on a system for dividing the state into 17 different biophysical provinces based on the distribution of plant species, climate and soils. Within each one of those, we hope to protect at least one good example of each type of ecosystem.

Question by Mr. Bortolotti: I am curious about when you divide the state up into geophysical units. Let's say if we have a shortage of one particular type that has been historically exploited, do you think a good idea is to try to reconstruct those habitats at the expense of what may exist currently? For example, you are short on certain forest types, and take away old fields or whatever. Will people who are accustomed to things like white-tailed deer, even if they don't belong there, accept the loss of species that don't belong there for what should be there?

Response by Mr. Hunter: Those are really complicated issues. I do believe in restoration ecology, the idea that we can reconstruct ecosystems that we have lost, and there are a number of examples. A relatively easy one is rangeland (i.e., prairies), where by controlling and regulating grazing, we can restore them.

One complicated issue is what is it we are trying to restore. North Americans usually focus on pre-European settlement ecosystems as the goal. I can just as easily make an argument that we should aim for pre-human settlement of North America ecosystems. Let's go back 10 000 years ago before people came across from Beringia and started wiping out most of our large mammals. Maybe we should be introducing cheetahs, rhinos, horses and camels to replace their relatives lost so recently. It is crazy, but I say it to make a point. I think we focus too quickly on pre-European settlement goals. For the average person on the street, if you ask them what would they like to see out there on the landscape; restoration ecology would be making it the way it was when they were ten years old. In short, there could be multiple goals, all of them valid. We probably shouldn't fixate on just one.

Question by Ms. Hannon: Do you think that the emphasis on biodiversity has in fact been a mistake because you value it sort of as a numbers game? Is it going to look a lot better on paper if you have 40 species instead of, say, 25? Because of the way things get translated from the way we talk about it in this room to someone out in the field, do you think in fact it may get distorted?

Response by Mr. Hunter: I think that is a real danger, and I have tried to argue strongly against it today. But I don't think focusing on biodiversity has been a mistake. I think the concepts I have laid out here (thinking about biodiversity on a larger scale) are not that hard to convey.

Question by Mr. Brace: Would you care to comment on the extent to which this old-growth idea is related to biodiversity, and how are you dealing with it where you are?

Response by Mr. Hunter: I am going to talk more about that issue tomorrow, but I'll offer a precis to that. In much of North America, (I know this isn't necessarily true in the northern part of Canada), old forests are very rare. We don't know very much about the vast bulk of the biota they hold. Consequently, when we are setting aside ecosystem reserves in this coarse-filter approach to saving biodiversity, old forests should be a higher priority, simply because they are relatively rare. They may well shelter species that are uniquely tied to them, like the spotted owl.

Question by Ms. Schmiegelow: I agree with you conceptually about the ecosystem, coarse-filter approach, but wish to touch upon a few things. Regionally, there tends to be single-species management. How do you network across jurisdictional scales as well as biological scales? And then there is always the question, of how much is enough, and how do you distribute that across jurisdictions or regions? How do you address those things?

Response by Mr. Hunter: Those are complicated questions, and clearly we need to think in terms of ecological boundaries, not political ones. For example, in the southwest corner of Maine, we have a tiny bit of some forest types that are much more common, farther south. These are some of the rarest ecosystems in the State of Maine. Unfortunately, that is the most expensive land in the State of Maine, because it is closest to Boston. We could spend all of our financial resources saving that rare ecosystem type in the State of Maine, and yet there is a fair amount of it in Massachusetts. So yes, we obviously have to think across ecological boundaries rather than political ones, but as you all know, that is easier said than done.

There was a second part of your question that I am missing here, the question relating species level management and ecosystem management.

Question by Ms. Schmiegelow: If you need to emphasize a high-priority species, but if there isn't communication between different jurisdictional levels, then you can end up with a problem doing it that way as well. I guess it just requires an interaction over a number of different scales, but operationally it is very difficult to do those things, and I am just wondering if you have any success stories?

Response by Mr. Hunter: No success stories. I have been working for the White House Task Force on the spotted owl as an external reviewer and there is a good example of the issue there. A number of us have been saying the spotted owl is just the tip of the iceberg, and we shouldn't focus on the spotted owl. We should think about the entire forest ecosystems.

There are many spotted owls at relatively high altitudes in areas that have been set aside as National Parks or wilderness areas but relatively few of them are left in low-altitude forests. It is easy to say, let's focus our attention on the areas that are easiest to protect, these high-altitude areas. Many are already protected, and that might do a pretty good job of protecting spotted owls. There are two arguments against that approach. One is the possibility that there are some genetic distinctions between high-altitude owls and low-altitude owls. The second argument returns us the coarse-filter. If we save only the high-altitude owls now, we may later have to deal with a group of other species associated with lower altitude owl habitat. So yes, there are often links between species level issues and ecosystem issues.

Question by Mr. Thomas: What are your views on using a few indicator species to represent an ecosystem?

Response by Mr. Hunter: The quick answer is, I don't like it. I like the idea of galvanizing public attention around flagship species like the spotted owl. The idea of indicator species make me nervous, because I think we as ecologists have exaggerated the tightness of interactions among different species. Thus, we assume that if we are taking care of one species, we can take care of a whole lot of others.

I don't doubt that we can sit here and describe ten different cases where it is the logical way to go, (for example, because the indicator species is easy to monitor), but conceptually, it troubles me.

ECOLOGICAL PROFILES OF BIRDS IN THE BOREAL FOREST OF WESTERN CANADA

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ABSTRACT

The ecological profiles of western boreal forest birds are presented according to seven ecological categories: taxonomic grouping; residency status and broad habitat requirements; migratory patterns; geographic origins; foraging guilds; nest site selection; and generalized habitat preference. The possible effects of forest management practices on birds in each classification are discussed. There are limits to the use of these categories to elucidate the relationships between birds and the ecosystem because of the overwhelming number of combinations (800) of ecological categories. Most categories or guilds have only one or two species within them, the implication being that research should be directed at individual species rather than towards an artificial category or combination of categories.

INTRODUCTION

The purpose of this paper is to define western boreal forest birds, and secondly to use various ecological categories to elucidate how forest management practices as well as other factors might influence birds in these categories. The classifications as presented in the Appendix and as summarized in the tables are often based on the application of arbitrary criteria. In the real world species do not fit neatly into groups and many fit into more than one grouping. This paper is therefore not intended to stand as a definitive work, but was designed to give an indication as to what species, and how many of them occur in each ecological group.

The area described as the western boreal forest includes the "predominately forest" portion of the boreal forest region (as defined by Rowe 1972) that lies to the west of the Ontario-Manitoba border. Bird distributions and ecological attributes are derived from Godfrey (1986).

COMPOSITION OF WESTERN BOREAL FOREST VERTEBRATES BY TAXONOMIC CATEGORIES

Birds (Class *Aves*) constitute the largest class of vertebrates in the western boreal forest, comprising over 72 percent of all vertebrates associated with this biotic region (Table 1). It is important to recognize the predominance of birds when designing forest management plans. The tendency in the past has been to place the emphasis on economically important species such as furbearers and ungulates.

RESIDENCY STATUS AND BROAD HABITAT REQUIREMENTS OF BIRDS IN THE WESTERN BOREAL FOREST

Table 2 shows birds grouped according to their status (whether they breed, or occur only as winter visitants or migrants), and according to broad habitat requirements (aquatic or terrestrial habitats). Breeding species are simply those species that carry out reproduction within the geographic area embraced in the western boreal forest region, but not necessarily within forest habitats. Winter visitants are species that spend

Table 1. Vertebrates of the western boreal forest

Group	No. of spp.	%
Fishes	38	10.9
Amphibians	5	1.4
Reptiles	1	0.2
Birds	252	72.2
Mammals	53	15.2
Total	349	100.0

the winter within the western boreal forest. Most of the latter breed in the Arctic or Subarctic and therefore tend to winter in open country or successional habitats. Transients are comprised chiefly of migratory waterbirds (waterfowl and shorebirds), or arctic-nesting terrestrial birds which generally occur in non-forest habitats.

Species have been termed terrestrial if they breed and forage in upland habitats, and aquatic if they carry out these activities in wetland habitats. There is considerable overlap between the two categories. For example, a species might forage in an aquatic habitat, but nest in a terrestrial environment. Specific examples include cavity-nesting waterfowl such as the common goldeneye (*Bucephala clangula*) and fish-eating raptors such as the osprey (*Pandion haliaetus*). Some other species which may more strictly be considered aquatic are also included. One such species is the solitary sandpiper (*Tringa solitaria*) which breeds and forages in areas of treed bog, and therefore might be adversely affected by harvesting operations in this habitat.

While the species previously mentioned might be viewed more properly as aquatic, sound management of forest resources critical to their successful reproduction and presence in the ecosystem. These species are marked with an asterisk in Appendix 1. Although it could be further argued that all species utilizing this biotic region could be affected at least indirectly by forest management practices, for purposes of clarity future discussion will be confined to those species that would be more directly impacted, (i.e., the terrestrial breeding species). This group includes nearly 59 percent of all birds species occurring within the region (Table 2).

MIGRATORY PATTERNS OF WESTERN BOREAL FOREST BIRDS

One of the most significant aspects of the life history of western boreal forest birds are their migratory patterns. Western boreal forest birds fall into three groups, which are evenly divided between long-distance migrants, short-distance migrants and permanent residents (Table 3). Long-distance migrants are birds that winter in the tropical environments. Many of these species are particularly sensitive to forest fragmentation on their breeding grounds, most respond negatively to increasing rates of deforestation on their wintering grounds. This group therefore, appears to be declining relative to the other two groups (Robbins *et al.* 1989; Askins *et al.* 1990).

Short distance migrants are species which winter mainly in the United States. They seem less susceptible to influences on either the breeding grounds or wintering grounds.

Table 2. Status and broad habitat requirements of birds of the western boreal forest

Status	Aquatic No. spp.	Aquatic %	Terrestrial No. spp.	Terrestrial %	Total No. spp.	Total %
Breeding Species	54	21.4	148	58.7	202	80.2
Winter Visitants	--	----	9	3.6	9	3.6
Migrants	35	13.9	6	2.4	41	16.3
Total	89	35.3	163	64.7	252	100.0

Table 3. Migratory patterns of western boreal forest birds

Migratory Pattern	No. spp.	%
Summer Residents		
Short-distance migrants	56	37.8
Long-distance migrants	59	39.9
Permanent Residents	33	22.3
Total	148	100.0

Permanent residents are those species spending the entire year in the western boreal forest. Species in this last group would in theory be at risk only from impacts on their combined winter breeding grounds and therefore might offer the best study subjects. Caution should, however, be exercised as many of these species are subject to local movements within the western boreal region itself. Some such as the red-breasted nuthatch (*Sitta canadensis)* and Cardueline finches (*Carduelinae*) are subject to erratic population eruptions south of the region (Bock and Lepthein 1972, 1976).

GEOGRAPHICAL ORIGINS OF WESTERN BOREAL FOREST BIRDS

The western boreal forest is the richest avifauna north of Mexico (Smith[1]; Robbins *et al.* 1986). This richness may be a result of the diverse geographic origins of the species involved (Table 4). The largest source is the boreal forest itself contributing over 41 percent of the species in the western boreal forest. The eastern or deciduous forest is a significant element in the Manitoba lowlands, while the western element increases in importance toward

[1]Smith, A.R. Unpubl. Number of species of breeding birds (Canada). Can. Wildl. Serv. Edmonton. Map.

Table 4. Geographical origin of terrestrial breeding birds

Geographic Region	No. spp.	%
Northern (boreal forest)	61	41.2
Eastern (deciduous forest)	33	22.3
Western (various habitats)	10	6.8
Central (grassland)	6	4.1
Pandemic (various habitats)	35	23.6
Introduced	3	2.0
Total	148	100.0

the foothills of the Rocky Mountains. The pandemic group includes a wide variety of species either of widespread occurrence or unknown origin.

The diverse geographic origins and the biogeography of the species of the western boreal forest must be recognized to understand how the niches are divided in this rather complex avifauna. An example of this is the chestnut-sided warbler (*Dendroica pensylvanica*), an eastern (deciduous forest species, which is common in the second growth in the eastern portions of the mixed-wood forests, but is almost absent in the western portions. The question that may be asked is "how is its niche divided in its absence?"

FORAGING GUILDS OF WESTERN BOREAL FOREST BIRDS

The foraging guilds used by western boreal forest birds may be the most important of all parameters. The groupings (Table 5) are defined by type of prey and subdivided (in the case of insectivores) by the method used in obtaining that prey. An interesting correlation is that the main prey chosen by each guild is related to the migratory pattern and to a lesser extent the choice of nest site.

The largest group are the omnivores; species that feed on plant and animal material. Granivores have been included in this group for while they eat plant food as adults, they feed their young on insects. Most omnivorous species are short-distance migrants. A notable exception are the *Corvidae* which save for the American crow (*Corvus brachyrhynchos*) are permanent residents.

As mentioned, the insectivores are subdivided according to the method of prey capture. Aerial feeders capture flying insects along edges and in open habitats. Not surprisingly these species migrate to winter in the tropics. Kinglets, vireos and warblers search for insects on foliage. Except for the golden-crowned kinglet (*Regulus satrapa*), which gleans on coniferous foliage, these species are almost entirely long-distance migrants. Trunk gleaners include the resident chickadees and nuthatches. Woodpeckers feed on insects excavated from trees. Except for short-distance migrant yellow-bellied sapsucker and the northern flicker (*Colaptes auritus*), woodpeckers are permanent residents.

Table 5. Terrestrial breeding birds by foraging guild

Foraging Guild	No. spp.	%	Examples
Nectivores	1	0.7	Hummingbirds
Insectivores			
flying insects	20	13.5	Swallows (aerial), Flycatchers (sally)
insects on leaves	33	22.2	Kinglets, Warblers
insects on trunks	6	4.1	Chickadees, Nuthatches
insects in trees	7	4.7	Woodpeckers
Omnivores	47	31.8	Thrushes, Sparrows, Blackbirds
Carnivores	19	12.8	Hawks, Owls
Piscivores	6	4.1	Mergansers, Bald Eagle, Kingfisher
Aquatic Invertebrates	9	6.1	Ducks, Shorebirds
TOTAL	148	100.0	

Carnivores include the hawks and owls. The former are generally short-distance migrants, while the latter are mainly permanent residents. The piscivores include the mergansers, osprey, bald eagle (*Haliaeetus leucocephalus*) and the belted kingfisher (*Megaceryle alcyon*). Species feeding on aquatic invertebrates include several species of ducks and the shorebirds. The last two groups are mainly migratory.

NEST SITE SELECTION BY WESTERN BOREAL FOREST BIRDS

Nest site selection (Table 6) is another aspect of the life history of western boreal forest birds that has major forest management implications. Species nesting in tree cavities would be the most vulnerable. These species require the largest mature trees for nesting, and would therefore be lost in the shorter harvest rotations, and by regulations calling for the removal of snags. Members of this group include the owls, woodpeckers, and nuthatches. Most cavity nesters are permanent residents. A few are short-distance migrants, while only one species, the great crested flycatcher (*Myiarchus crinitus*) is a long-distance migrant.

Impacts are less clearly interpreted for the other groups. Forest fragmentation and the subsequent increase in brown-headed cowbirds (*Molothrus ater*) may be manifest with species nesting on the ground or shrubs in edge or successional habitats (Brittingham and Temple 1983). By contrast non-passerines and species nesting in tree or other cavities are almost never parasitized.

GENERALIZED HABITAT PREFERENCE OF WESTERN BOREAL FOREST BIRDS

Although the data in the Table 7 are highly generalized, they do to some extent reflect the impact of both forest fragmentation, and the length of harvest rotations on the avifauna of the western boreal forest. For example, short harvest rotations would impact the 54 percent of species that require mature or old growth forest. Increased edge from clear-cuts and road construction with subsequent invasion by

Table 6. Nest sites of terrestrial breeding birds

Nest site	No. spp.	%
Ground	40	27.0
Shrub	17	11.5
Tree	50	33.8
Tree Cavity	28	18.9
Other Cavity *	12	8.1
no nest (Brown-headed Cowbird)	1	0.7
Total	148	100.0

* Nest in or on cliff, under uprooted tree, in building, or under bridge.

cowbirds and predators might adversely affect those species preferring deep forest habitats (i.e., mature or old growth forest, without edge).

SUMMARY AND CONCLUSIONS

In summary an analysis of the boreal forest by various ecological categories can help elucidate some relationships in the ecosystem. There are, however, limits to this procedure. If, for example, we examine all the combinations of the various categories in tables 3, 5, 6 and 7, there are over 800 possible categories. Clearly with 148 species under discussion only a fraction of the categories would be occupied by a guild. In reality the species sort into about 75 guilds, most with only one or two species, and the largest with only seven species. The upshot of this is that in practice there is not much difference between studying a guild and studying a species. Research efforts should therefore be directed toward studies of individual species rather than on an artificial category or a combination of categories.

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Table 7. Terrestrial breeding birds by habitat preference

Habitat	No. of species	Percent of species
Mature or old growth forest, without edge	44	29.7
Mature or old growth forest, with edge	36	24.3
Young or immature forest	31	20.9
Recent burns or clear-cuts	15	10.1
[1]Other	8	5.4
Aquatic	14	9.5
TOTAL	148	100.0

[1]Urban and cliff dewlling species.

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DISCUSSION

Question by Mr. Farr: I wonder if you could explain what your concept of edge is, when you are deciding which species are mature forest non-edge versus mature forest edges?

Response by Mr. Smith: What I meant by edge was anything that was a change in habitat. I mean not necessarily a sharp edge as between mature and immature forest types, but, perhaps an edge created by a change of habitat (i.e., deciduous forests to conifers). It doesn't have to be, however you use the expression, a hard edge. It could be a soft edge.

Appendix 1. Systematic list of western boreal forest birds.

Species	Migratory Pattern	Geog. Origin	Foraging Guild	Nest Site	Habitat Pref.
* Great Blue Heron	SD	PA	PI	TR	AQ
* Wood Duck	SD	EA	AI	CT	AQ
* Common Goldeneye	SD	NO	AI	CT	AQ
* Bufflehead	SD	NO	AI	CT	AQ
* Hooded Merganser	SD	EA	PI	CT	AQ
* Common Merganser	SD	NO	PI	CT	AQ
Turkey Vulture	LD	PA	CA	CO	RE
* Osprey	LD	PA	PI	TR	AQ
* Bald Eagle	PR	NO	PI	TR	AQ
Norhtern Harrier	SD	PA	CA	GR	RE
Sharp-shinned Hawk	SD	PA	CA	TR	ME
Cooper's Hawk	SD	PA	CA	TR	ME
Northern Goshawk	PR	NO	CA	TR	ME
Broad-winged Hawk	LD	EA	CA	TR	MO
Red-tailed Hawk	SD	PA	CA	TR	ME
Golden Eagle	SD	WE	CA	CO	RE
American Kestrel	SD	PA	CA	CT	ME
Merlin	SD	NO	CA	TR	ME
Peregrine Falcon	LD	PA	CA	CO	RE
Spruce Grouse	PR	NO	OM	CT	MO
Ruffed Grouse	PR	EA	OM	TR	MO
Sharp-tailed Grouse	PR	CE	OM	CO	RE
Killdeer	SD	PA	OM	GR	RE
* Greater Yellowlegs	SD	NO	AI	GR	AQ
* Lesser Yellowlegs	SD	NO	AI	GR	AQ
* Solitary Sandpiper	SD	NO	AI	GR	AQ
Upland Sandpiper	SD	CE	AI	GR	RE
* Short-billed Dowitcher	SD	NO	AI	GR	AQ
* Bonaparte's Gull	LD	NO	AI	TR	AQ
Rock Dove	PR	IN	OM	CO	OT
Mourning Dove	SD	PA	OM	GR	YI
Black-billed Cuckoo	LD	EA	IL	TR	YI

Appendix 1. Systematic list of western boreal forest birds.

Species	Migratory Pattern	Geog. Origin	Foraging Guild	Nest Site	Habitat Pref.
Great Horned Owl	PR	PA	CA	TR	ME
Northern Hawk-Owl	PR	NO	CA	CT	ME
Barred Owl	PR	EA	CA	CT	MO
Great Gray Owl	PR	NO	CA	TR	ME
Long-eared Owl	SD	PA	CA	TR	YI
Short-eared Owl	PR	PA	CA	GR	RE
Boreal Owl	PR	NO	CA	CT	MO
Northern Saw-whet Owl	PR	NO	CA	CT	MO
Common Nighthawk	LD	PA	IA	GR	RE
Whip-poor-will	LD	EA	IA	GR	ME
Chimney Swift	LD	EA	IA	CT	ME
Ruby-throated Hummingbird	LD	EA	NE	TR	ME
* Belted Kingfisher	SD	PA	PI	CO	AQ
Yellow-bellied Sapsucker	SD	NO	IE	CT	MO
Downy Woodpecker	PR	PA	IE	CT	MO
Hairy Woodpecker	PR	NO	IE	CT	MO
Three-toed Woodpecker	PR	NO	IE	CT	MO
Black-backed Woodpecker	PR	NO	IE	CT	MO
Northern Flicker	PR	PA	IE	CT	MO
Pileated Woodpecker	SD	EA	IE	CT	ME
Olive-sided Flycatcher	PR	NO	IE	CT	MO
Western Wood-Pewee	LD	WE	IA	TR	ME
Eastern Wood-Pewee	LD	EA	IA	TR	ME
Yellow-bellied Flycatcher	LD	NO	IA	TR	ME
Alder Flycatcher	LD	NO	IA	GR	ME
Least Flycatcher	LD	EA	IA	SH	YI
Eastern Phoebe	SD	EA	IA	TR	MO
Say's Phoebe	LD	WE	IA	CO	OT
Great Crested Flycatcher	LD	EA	IA	CO	OT
Eastern Kingbird	LD	EA	IA	CT	ME
Purple Martin	LD	PA	IA	CT	YI
Tree Swallow	SD	NO	IA	CT	ME

Appendix 1. Systematic list of western boreal forest birds.

Species	Migratory Pattern	Geog. Origin	Foraging Guild	Nest Site	Habitat Pref.
Bank Swallow	LD	PA	IA	CT	ME
Cliff Swallow	LD	PA	IA	CO	OT
Barn Swallow	LD	PA	IA	CO	OT
Gray Jay	PR	NO	OM	TR	MO
Blue Jay	PR	EA	OM	TR	ME
Black-billed Magpie	PR	WE	OM	TR	YI
American Crow	SD	PA	OM	TR	ME
Common Raven	PR	NO	OM	TR	ME
Black-capped Chickadee	PR	PA	IT	CT	MO
Boreal Chickadee	PR	NO	IT	CT	MO
Red-breasted Nuthatch	PR	NO	IT	CT	MO
White-breasted Nuthatch	PR	PA	IT	CT	MO
Brown Creeper	PR	NO	IT	TR	MO
House Wren	LD	PA	IL	CT	YI
Winter Wren	SD	NO	IL	CO	MO
Golden-crowned Kinglet	PR	NO	IL	TR	MO
Ruby-crowned Kinglet	SD	NO	IL	TR	MO
Mountain Bluebird	SD	WE	IA	CT	ME
Veery	LD	NO	OM	GR	MO
Swainson's Thrush	LD	NO	OM	GR	MO
Hermit Thrush	SD	NO	OM	GR	MO
American Robin	SD	PA	OM	SH	ME
Gray Catbird	SD	EA	OM	SH	YI
Brown Thrasher	SD	EA	OM	SH	YI
Sprague's Pipet	SD	CE	OM	GR	RE
Bohemian Waxwing	PR	WE	OM	TR	ME
Cedar Waxwing	SD	PA	OM	TR	YI
European Starling	SD	IN	OM	CT	ME
Solitary Vireo	SD	NO	IL	TR	ME
Warbling Vireo	LD	WE	IL	TR	ME
Philadelphia Vireo	LD	NO	IL	TR	YI
Red-eyed Vireo	LD	EA	IL	TR	MO

Appendix 1. Systematic list of western boreal forest birds.

Species	Migratory Pattern	Geog. Origin	Foraging Guild	Nest Site	Habitat Pref.
Golden-winged Warbler	LD	EA	IL	GR	YI
Tennessee Warbler	LD	NO	IL	GR	MO
Orange-crowned Warbler	SD	NO	IL	GR	YI
Nashville Warbler	LD	NO	IL	GR	YI
Yellow Warbler	LD	PA	IL	SH	YI
Chestnut-sided Warbler	LD	EA	IL	SH	YI
Magnolia Warbler	LD	NO	IL	SH	YI
Cape May Warbler	LD	NO	IL	TR	MO
Black-throated Blue Warbler	LD	EA	IL	SH	YI
Yellow-rumped Warbler	SD	NO	IL	TR	MO
Black-throated Green Warbler	LD	EA	IL	TR	MO
Blackburnian Warbler	LD	NO	IL	TR	MO
Pine Warbler	SD	EA	IL	TR	MO
Palm Warbler	LD	NO	IL	GR	YI
Bay-breasted Warbler	LD	NO	IL	TR	MO
Blackpoll Warbler	LD	NO	IL	SH	YI
Black-and-White Warbler	LD	EA	IT	GR	ME
American Redstart	LD	EA	IA	TR	YI
Ovenbird	LD	EA	IL	GR	MO
Northern Waterthrush	LD	NO	IL	GR	ME
Connecticut Warbler	LD	NO	IL	GR	MO
Mourning Warbler	LD	NO	IL	GR	YI
Wilson's Warbler	LD	NO	IL	GR	YI
Canada Warbler	LD	NO	IL	GR	ME
Scarlet Tanager	LD	EA	IL	TR	MO
Western Tanager	LD	WE	IL	TR	MO
Rose-breasted Grosbeak	LD	EA	OM	SH	MO
Indigo Bunting	LD	EA	OM	SH	YI
Chipping Sparrow	LD	PA	OM	SH	MO
Clay-coloured Sparrow	LD	CE	OM	SH	YI
Vesper Sparrow	SD	PA	OM	SH	RE
Savannah Sparrow	SD	PA	OM	SH	RE

Appendix 1. Systematic list of western boreal forest birds.

Species	Migratory Pattern	Geog. Origin	Foraging Guild	Nest Site	Habitat Pref.
Fox Sparrow	SD	NO	OM	SH	YI
Song Sparrow	SD	PA	OM	SH	YI
Lincoln's Sparrow	LD	NO	OM	GR	YI
Swamp Sparrow	SD	NO	OM	GR	YI
White-throated Sparrow	SD	NO	OM	GR	YI
Dark-eyed Junco	SD	NO	OM	GR	ME
Bobolink	LD	PA	OM	GR	RE
Western Meadowlark	SD	CE	OM	GR	RE
Rusty Blackbird	SD	NO	OM	SH	MI
Brewer's Blackbird	SD	WE	OM	SH	RE
Common Grackle	SD	EA	OM	TR	ME
Brown-headed Cowbird	SD	CE	OM	NN	OT
Northern Oriole	LD	EA	OM	TR	ME
Purple Finch	SD	NO	OM	TR	MO
Red Crossbill	PR	NO	OM	TR	MO
White-winged Crossbill	PR	NO	OM	TR	MO
Pine Siskin	SD	NO	OM	TR	MO
American Goldfinch	SD	EA	OM	SH	YI
Evening Grosbeak	PR	WE	OM	TR	MO
House Sparrow	PR	IN	OM	CO	OT

KEY TO ABBREVIATIONS;

MIGRATORY PATTERNGEOGRAPHIC ORIGIN

SD: Short-distance MigrantEA: Eastern
LD: Long-distance MigrantCE: Central
PR: Permanent ResidentIN: Introduced
NO: Northern
PA: Pandemic
WE: Western

FORAGING GUILD

AI: Aquatic invertebrates
CA: Carnivores
NE: Nectivores
IF: Insectivores; flying insects (aerial and sallying feeders)

IL: Insectivores; insects on leaves (leaf gleaners)
IT: Insectivores; insects on trunks (trunk gleaners)
IE: Insectivores; insects in trees (excavators)
OM: Omnivores

NEST SITESHABITAT PREFERENCE (Generalized):

CT: Cavity, treeAQ: Aquatic
CO: Cavity, other (cliff, building)ME: Mature, Old Growth, with edge
SH: ShrubMO: Mature, Old Growth, Without edge
TR: TreeRE: Recently burned or clear-cut
NN: No nest (Brown-headed Cowbird)OT: Other
YI: Young, Immature

* species foraging in aquatic habitats but requiring upland or bog habitat for nesting.

WILDFIRE AND THE HISTORICAL HABITATS OF THE BOREAL FOREST AVIFAUNA

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ABSTRACT

In the centuries preceding European settlement fire created great diversity in the vegetation of the boreal forest of the prairie provinces of Manitoba, Saskatchewan and Alberta. A model of presettlement forest structure is presented based on a negative exponential curve of percent area over age classes for a fire cycle of 50 years, and on hypotheses about tree species composition. The model showed a reasonable fit to the distribution of bird species over the range of forest stand age, and composition classes predicted. Old forest (150 years plus) would have been limited to about 5% of the land area, and conifer forest to about 11% supplemented by muskeg and wet lowland forests. The avifauna adapted to occupy the niches available. Management should maintain adequate proportions of the forest stands age and composition classes present in the presettlement forest, ideally in similar proportions.

INTRODUCTION

Wildfire has been a significant agent of vegetation change and renewal in most of the world's terrestrial ecosystems (Kozlowski and Ahlgren 1974; Zackrisson 1980). The boreal forests of North America have been highly susceptible to fire over the millennia (Heinselman 1981; Barney and Stocks 1983). In remote areas lightning has been the major cause of fire ignitions (Requa 1964; Heinselman 1981; Barney and Stocks 1983). However, aboriginal peoples used fire to manage vegetation in certain circumstances in accordance with their traditional knowledge of fire effects (Lewis 1977).

The importance of fire in natural ecosystems is now widely recognised (Wright and Bailey 1982). It is understood that fire is vital to the maintenance of many plant communities and for the animal life that depends on those communities (Heinselman 1981). The purpose of the present paper is to review the relationship of migratory songbirds that breed in the Canadian boreal forest to the habitat conditions created by burning in the historic period before the introduction of fire control.

THE BOREAL FIRE REGIME

It is widely recognized that wildfire has always been a major environmental factor in the boreal forest of the northern hemisphere (Barney and Stocks 1983). In presettlement times fire was a random affair in North America. What burned and what did not depended on the interplay of climatic variables with sources of fire ignition (Van Wagner 1983). Within areas affected by fires, fuel type and topography influenced fire intensity, and the extent of the impact on vegetation. In boreal forests, fires usually kill most of the existing stand, thereby returning the forest vegetational succession to a herb dominated stage. Herbs are followed by regrowth of woody shrubs and saplings, mostly deciduous, but with conifer seedlings intermixed. In about 20 years saplings have become small trees, shading out shrubs and herbaceous growth and forming a pole-sized mixedwood forest of increasing density. Forty to 60 years later a mature forest of sawlog-sized trees begins to form, with conifers becoming increasingly dominant. After about 100 years tree mortality opens the stand so shrubs can again become established.

The effect of random fires is to create stands of a variety of age classes. Distribution of forest area among the year classes approximates a negative exponential distribution (Figure 1) with an average age equal to the prevailing fire cycle (Van Wagner 1978, 1983). The fire cycle in a region is the number of years required, at the existing rate of burning, to burn over an area equal to the total area of the region. Some sections of the region may burn over several times while other remain untouched through several cycles. Heinselman (1981) analyzed the existing information on fire cycles in various ecoregions of North America. He estimated the length of cycles in the boreal forest at 50 to 150 years with 50 to 100 years characterizing much

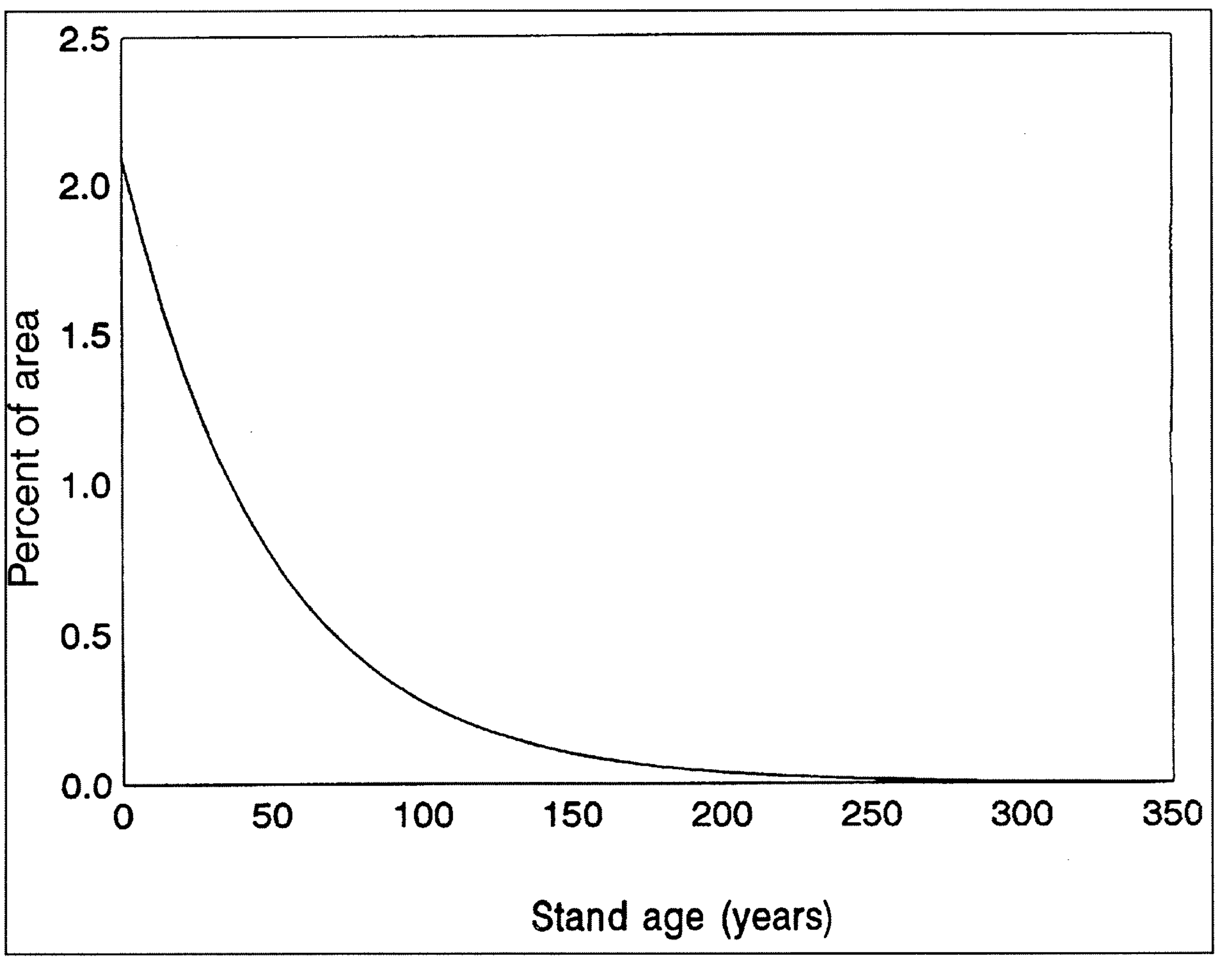

Figure 1. Negative exponential model of age classes in forest with 50 year fire cycle (after Van Wagner 1978).

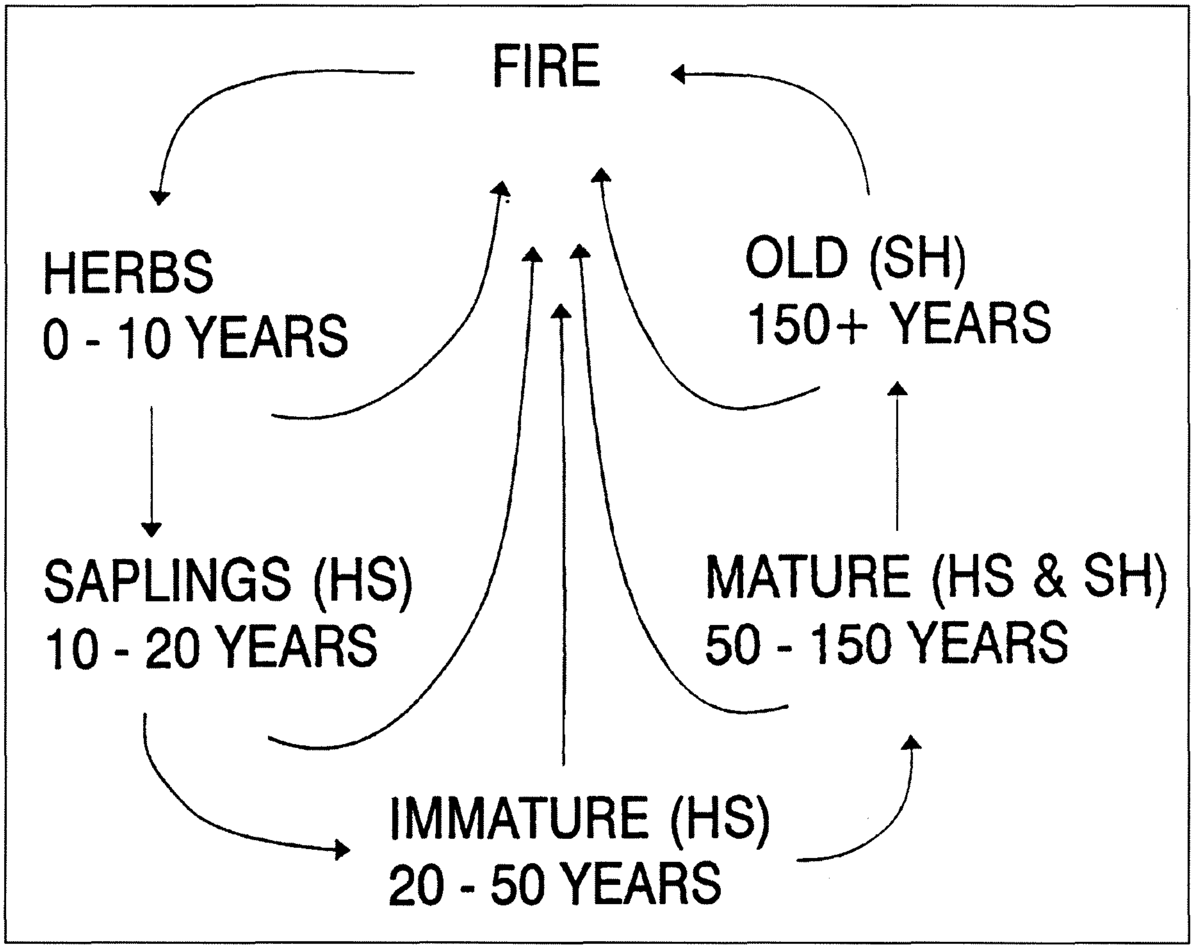

Figure 2. Boreal forest successional pathways (HS is hardwood dominated mixedwood, SH is softwood dominated mixedwood).

of the area. The aspen (*Populus* spp.) parkland was estimated to have burned on a cycle of about 10 years in presettlement times. Montane and subalpine forests on the east slopes of the Rocky Mountains exhibit a fire cycle of about 25 years in dry montane valleys, 50 years in lower subalpine forests and over 100 years at higher elevations (Tande 1977; Arno 1976). Boreal mixedwood forest of northern Alberta burned on a cycle estimated at 38 years (Murphy 1985).

Fire cycle length has a profound influence on the plant communities that occupy an area (Cattelino *et al.* 1979). Areas with a fire cycle of less than 10 years will not escape the grass/forb stage (Figure 2). Cycles of 20 years permit the establishment of sapling stands dominated by deciduous species like trembling aspen (*Populus tremuloides*), and white birch (*Betula papyrifera*), but with seedlings of some coniferous species like white spruce (*Picea glauca*) gaining a foothold in the understory. Longer cycles of 50-100 years permit the establishment of mature stands of mixed deciduous and coniferous forest. When cycles are longer than 100 years there is opportunity for the formation of stands dominated by conifers as the shorter-lived aspens and birches succumb to decay. Boreal forest landscapes thus contain considerable diversity in age class, and in tree species composition. However, a fairly large area is required to encompass the full range of that diversity. The variety of tree age and species composition is reflected in diversity of vertical thickness of the vegetation, and of its structure. Fire has in the past controlled the nature and variety of habitat available to nesting migratory songbirds, and to other wildlife species. Boreal forest songbirds have been presented with a patchy arrangement of habitat units that included all age classes (Van Wagner 1978). Additional structural complexity is created by the occurrence of low-intensity surface fires that kill some trees leaving open stands (Heinselman 1981).

Boreal forest tree species are well adapted for reproduction following fire (Heinselman 1981). Most feature a strong capacity to sprout from the roots; to have cones that are fire resistant; to have light seeds that can be carried for considerable distances by the wind; or some combination of the above characteristics. The boreal flora developed during the Tertiary Period as a combination of plant taxa evolved in earlier stages of the earth's history (Larsen 1980). In the course of its development the boreal flora migrated, and the area of its distribution fluctuated with the advances and retreats of the Pleistocene continental glaciations. There has been a long period during which something similar to the present boreal forest has been available as a habitat for birds. The opportunity has therefore existed for invasion and adaptation to the structural habitats provided by that forest. The mosaic of habitat types in the presettlement fire-controlled forest provides a well-dispersed diversity of habitat for generalist wildlife species. As well, it periodically renews the supply of habitat required by habitat specialist species (Alexander and Euler 1981).

HABITAT MODEL

The length of the fire cycle no doubt varied considerably across the northern prairie provinces. It varied from less than 50 years in the southern and western parts of the region (Murphy 1985) to 100 years or more in the open subarctic transition forest of northern Saskatchewan and Manitoba. In the light of the 38-year cycle documented by Murphy (1985) for northern Alberta; it seems reasonable to assume an average cycle length of 50 years for the region. No doubt the cycle length varied somewhat over the centuries in response to wetter or dryer climatic periods.

From this hypothetical cycle length it is possible to construct a model of age class, and species composition for the upland forests of the northern prairie provinces in the presettlement past. However, it must be kept in mind that scattered throughout the region were large areas of muskeg that would have provided additional open coniferous habitat for breeding birds.

The model of upland forest would be applicable only to large tracts of country. Probably a minimum of 10 000 km^2 would be required for age class to approach that predicted by the model and shown in Figure 3. Estimates of area distribution from the negative exponential curve can be combined with the model of species composition in relation to age (Figure 2), to derive a model of the proportion of upland forest area in various composition classes (Figure 4).

HABITAT SELECTION BY BIRDS

The major categories of forest cover-types previously described would present themselves to incoming birds seeking nest sites as interspersed archipelagos of islands. Investigations of species assemblages on islands and in isolated "islands" of habitat have shown that number of species of birds and other organisms occupying them is roughly proportional to the island area (Shafer 1990). It was therefore hypothesized that the number of species of breeding birds occurring in major structural categories of forest should be proportional to the area of those categories. The hypothesis was further explored.

Upland boreal forests were considered to be composed of the following broad, ecologically significant tree species categories: coniferous, mixedwood and deciduous. Each species category was further divided into age classes in a somewhat arbitrary classification as follows: "Young" (0-20 years) dominated by herbaceous plants and deciduous saplings; "Immature" (20-50 years) where small trees largely of deciduous species, dominate. "Mature" (over 50 years) with trees reaching maturity, and with an increasing proportion of conifers as the shorter-lived aspens and birches succumb to decay. Forest stands over 150 years were considered to be "old" and consist of spruce-dominated stands. The term "old growth" was not considered appropriate for application to the fire-dominated boreal forest. "Old growth" should be reserved for application to old stands (over 300 years since significant disturbance) of the Pacific Coastal Rain Forest, to deciduous forests in eastern North America where a climax successional stage has been identified, and to stands in other regions where disturbances that destroy entire stands are relatively rare.

Bird species occurring in the boreal forest of Western Canada were assigned to each forest habitat category by review of habitat requirements. These are described in standard references on birds and selected reports of studies conducted in the region (Bent et al.1929; Pough 1949; Palmer 1962; Godfrey 1966; Salt 1973; Salt and Salt 1976; Udvardy 1977; Francis and Lumbis 1979; Holroyd and Van Tighem 1983; Farrand 1983).

Bird species were assigned to habitats by listing each species in every category that corresponded to habitat the species was reported as using during the breeding season. Therefore most species were listed in more than one habitat category. A second analysis compared the proportion of species using habitat categories. These were obtained by the same method with proportions obtained by assigning each species to only that category judged most important to it. Differences in the proportional distribution of species over the habitat categories were small, so further analysis focused on the distribution as obtained by the first method.

The 146 species of forest-nesting birds considered were widely distributed among the major habitat categories (Table 1). The broad distribution of use shows that every category of upland habitat is used by some species in the regional avifauna. The average number of categories used per bird species was between three and four, showing a substantial average level of habitat generalization. The bird use was distributed over the forest age classes in roughly the same proportion as the forest area (Figure 3). Bird distribution among the three species composition categories also roughly approximated that of forest area based on the negative exponential curve for a 50-year fire cycle (Figure 4).

IMPLICATIONS OF THE SPECIES/AREA RELATIONSHIP

Figure 3 indicates that under the presettlement fire regime the proportion of the upland forest in old age classes would have been limited to about 5%. Old forest is usually considered to be required habitat for a number of species like pileated woodpecker (*Dryocopus pileatus*) and brown creepers (*Certhia americana*). It is therefore unlikely that habitat for such species was ever universal. However, even 5% of Alberta's 330 000 km^2 of forest land (Bonner 1982) would have totalled 16 000 km^2 of potential habitat in widely scattered patches. That area would have been sufficient to maintain substantial populations.

Pileated woodpeckers and possibly other species may not only require old forest but need extensive tracts of it for the establishment of breeding territories (Mellen et al. 1992). The area of stands of various forest age and composition classes depended, (in the period before effective fire suppression); on the accident of fire ignition interacting with topography and weather. In

Alberta during the period 1918-1950 most of the burned area resulted from a few large fires. Most fires were of small extent (Murphy 1985). The weighted mean fire area was 434 ha (calculated from data in Murphy 1985). However, large fires may skip as much as 15-20% of the area within their perimeters (Eberhart and Woodard 1987; Schaefer and Pruitt 1991) and leave some

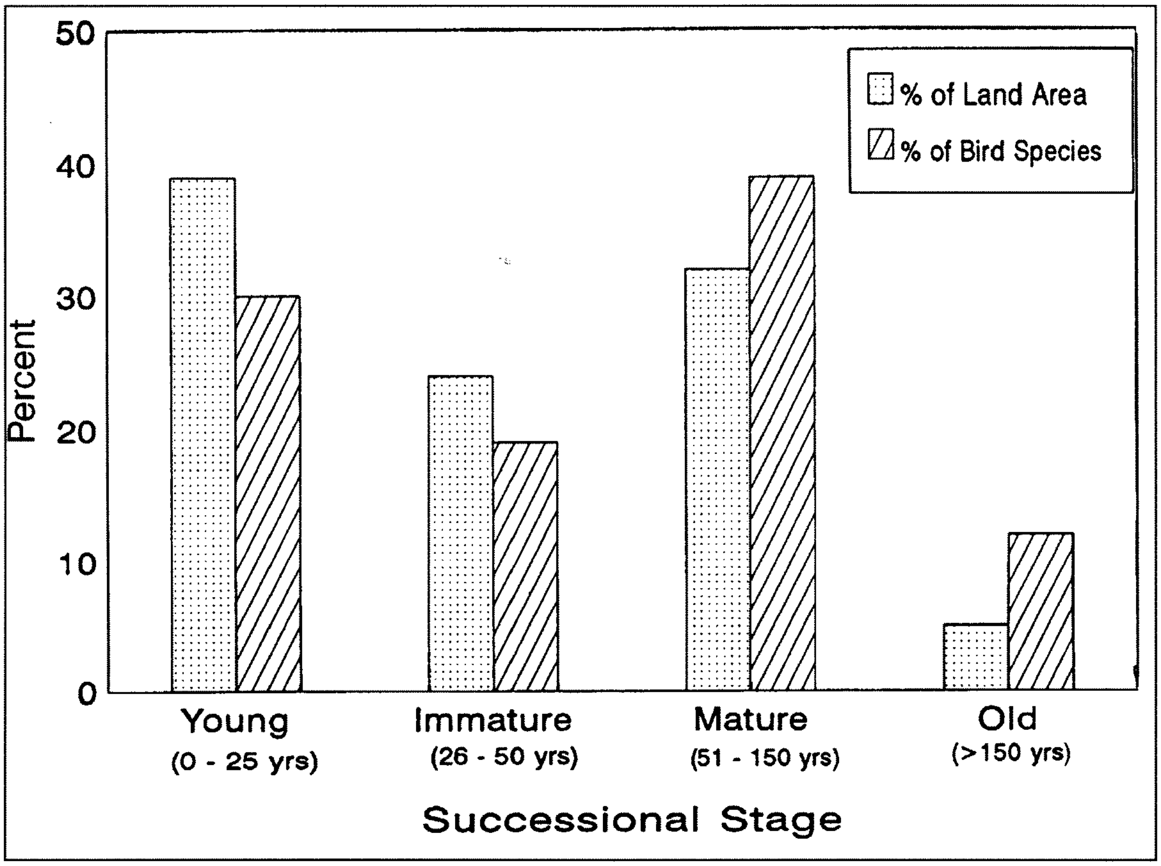

Figure 3. Percent of 146 species of boreal forest birds using various age classes compared to percent of area in those classes from the negative exponential curve (Van Wagner 1978) for a 50 year fire cycle.

areas only lightly burned (Gasoway and DuBois 1985). Such unburned areas reduce the size of forest stands originating from the burn. In the course of vegetative succession following the fire (Figure 2) parts of the stand may be burned by new fires. The result is a mosaic pattern of small areas of differing age classes, and species composition. One study (Miller 1976) in northern Manitoba found that stands of upland forest were on the order of 4 ha.

Small stand size combined with the low percentage of old forest described above must have meant that breeding habitat was extremely limited for birds such as pileated woodpeckers that require large tracts of old forest. However,

Table 1. Habitats used during the breeding season by 146 species of breeding birds in the boreal forests of Canada's prairie provinces. Species were listed in all categories that they were reported to use

	Species composition			
Age class	Deciduous	Mixedwood	Coniferous	Totals
Young	48	61	54	163
(0-25 years)	(9%)	(11%)	(10%)	(30%)
Immature	30	38	33	101
(26-50 years)	(6%)	(7%)	(6%)	(19%)
Mature	52	82	77	211
(51-150 years)	(8%)	(15%)	(14%)	(39%)
Old	13	27	21	61
(150 + years)	(3%)	(5%)	(4%)	(11%)
Totals	143	208	185	536
	(27%)	(39%)	(35%)	100%

the protection of some areas by water bodies and wetlands, and the random occurrence of fires would have provided some substantial blocks of old forest. This would have been buttressed by additional adjacent areas in the mature class during most periods since the post-glacial reestablishment of forest in the region.

The percentage of bird species using old forests considerably exceeds the percentage of land area estimated to be in that category based on a 50-year fire cycle (Figure 3). Possible explanations of this fact include the following: (a) The old forest with its large trees, snags and woody debris may provide more niches; (b) Many bird species that use mature forests will also use old forest, as will some species that are more common in young and immature age categories. The latter would be able to find patches of suitable habitat scattered throughout old stands. Conversely, where old stands are burned; variations in burning intensity often leave many elements of old forest like snags, large live trees, and dead wood scattered throughout stands of young age classes (Bergstedt and Niemi 1974). New insect-infested snags are particularly attractive to woodpeckers (Blackford 1955) that otherwise would be associated with unburned stands in the old age classes. Cavities excavated by woodpeckers hold other cavity-nesting species in young and immature stands; (c) The larger than predicted percentage of bird species using the old forest combined with the somewhat greater use of the mature age category, and the less than expected use of the younger categories, may occur because the 50-year fire cycle assumed for the model is too short for parts of the region. If a longer fire cycle had been assumed, the predicted area percentage in old stands would have been greater. For instance, a cycle of 100 years would allow 22% of the area to exist in the over 150 year age class and correspondingly reduce the predicted area in younger age classes. Arguments can be made to justify any one of several fire cycles as being an average for the presettlement boreal forest. If the negative exponential equation is solved for fire cycle length using the percentage of bird species as a predicator of the proportion of land area in the different age classes; the result is about 70 years. Seventy years is defensible as a mean fire cycle length for the boreal forest of the northern prairie provinces because it is in the middle of the 50 to 100 range reported by Heinselman (1981). The negative exponential model predicts that a fire cycle of 70 years would produce an average area of old (> 150 years) forest of 11%.

Bird species use of coniferous forest exceeds that expected from the area percentages, but is somewhat less than expected in the deciduous and mixedwood forest (Figure 4). The difference probably related to the exclusion of muskeg area from the model. Muskeg and interspersed wet forest sites support considerable tree growth that is almost all coniferous in the northern prairie provinces; largely black spruce (*Picea mariana*) (Rowe 1972). Thirty-six percent of the forest land in the prairie provinces is classed as "unproductive". Much of that is muskeg (calculated from Bonner 1982). In addition, there are extensive areas of glacial outwash sand plains where jack pine (*Pinus banksiana*) dominates all age classes (Rowe 1972). There are large areas that have probably supported at least scattered coniferous tree cover for several thousand years. If the percentage in Figure 4 are corrected for the unproductive area, each of the three species composition classes would have a third of the area. This would fit the bird species distribution better, but showing less bird use of conifers than expected rather than more.

Another prediction that can derived from the habitat model is that there must always have been a great deal of edge habitat in the boreal forest. These edges are of two kinds: long-lasting edges between open muskeg and forest, and temporary edges between areas of young forest regenerating after fire and unburned stands. Temporary edges would also persist to some extent as boundaries between stands of different species composition in more mature forest.

If edges have long existed as a major habitat element in the boreal forest it is to be expected that birds have adapted to use them. The sources on habitat information indicate that 96 of the 146 species considered often locate their nests on edges.

The suggested model of land area proportions in age class, and species composition categories could have been valid only over large areas. The area proportions would also have been averages for lengthy time periods. The area burned varies with weather conditions from year to year. It seems to be responding to weather cycles of approximately 10 years superimposed on a longer-term series of fluctuations that produced periods when conditions permitted episodes of severe burning (Van Wagner 1988). However, there must always have been sufficient area in each age and tree species category to maintain viable populations of the existing bird species mix.

SUMMARY AND CONCLUSIONS

The point of this analysis is that there never was a situation in the boreal forest when the region was clothed in a primeval forest of old trees. All age classes were present if regions of sufficient size were considered over a lengthy time period. Therefore a wide variety of structural habitats were available to breeding birds. Following the last glaciation the avifauna of the region developed by the invasion of pre-adapted bird species. Evolutionary adaptation of species allowed use of the full variety of habitats that became available.

As a consequence of the historical development of bird species and their habitats in the boreal forest there are species capable of using any combination of age class and tree species composition that may occur. Changes

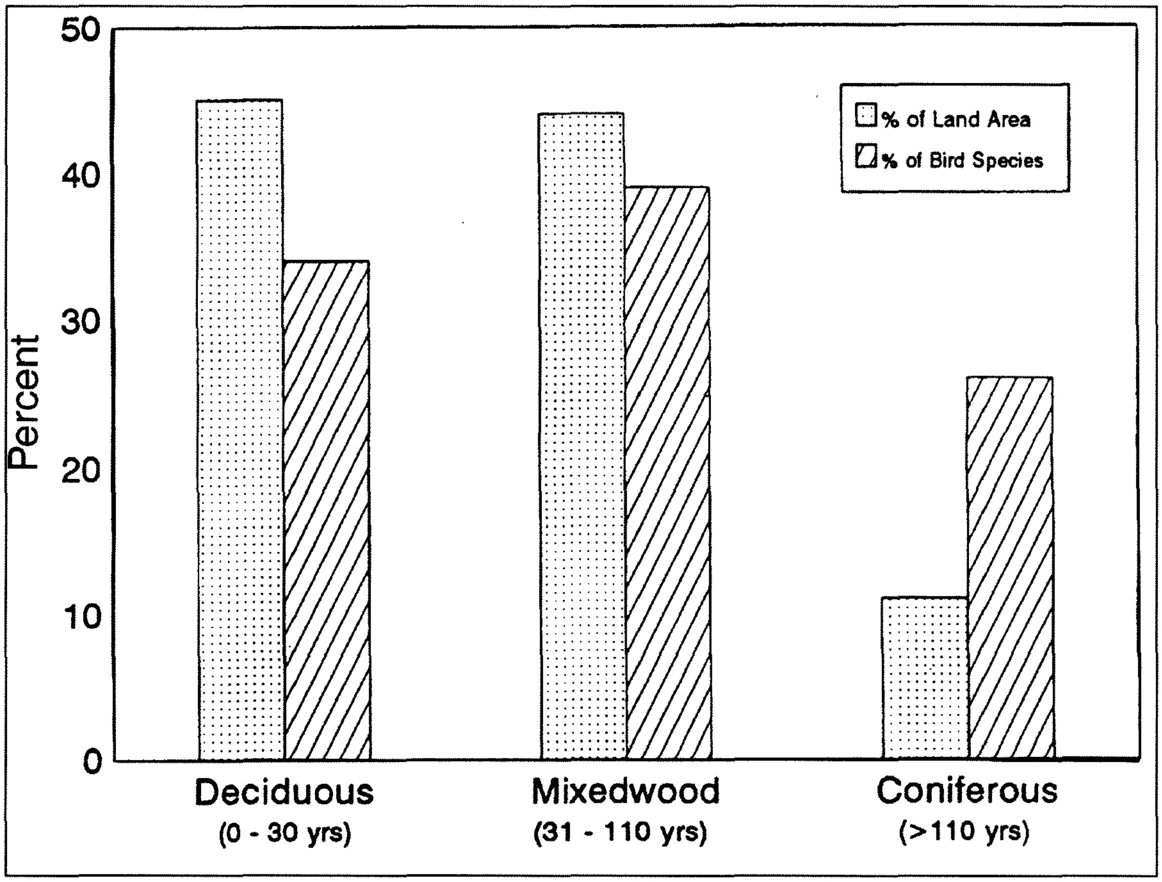

Figure 4. Percent of 146 breeding birds using tree species composition classes compared to proportion of forest area predicted from the negative exponential curve (Van Wagner 1978) for a 50 year fire cycle.

due to wildfire or human land management activities in the boreal forest can be expected to impact negatively on some bird species but benefit others. If the goal of sustainable development in the boreal forest is to retain the historic biodiversity of the region; then management must maintain an adequate percentage of the forest area in the major age, and species composition classes found in the presettlement forest.

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DISCUSSION

Question by Mr. Bortolotti: There was lots of overlap in where species were found in these different habitats, young versus old, for example. Consistent with what we were talking about, a numbers game looking more at whether some species were in unique positions, did you look at whether any of those particular habitats had a higher proportion of unique species? For example, the species that were found in the old growth, were they typically only found there, and was there more overlapping in the younger age classes?

Response by Mr. Telfer: I think that the species of the old growth, particularly the pileated woodpeckers, because they need big trees or big holes. They are a big bird, almost chicken size, and so they really needed the old forest. They have got to have big trees. With these short fire cycles, there would not have been very many big trees of any kind that any species at all could have used. They are still here, and they have been around, but the type of habitat they require must have been quite limited historically. They would have been limited to tracts of old growth with probably associated tracts of mature forest, but not old. It seldom happened to occur in large complexes so the habitat for those birds must have been quite limited. Brown creepers are another species that need old decrepit trees with the bark falling off, and so on for nesting. They forage on these trees as well. This kind of habitat, these old species of old growth, old-forest species are a problem, no doubt.

Question by Mr. Bortolotti: I am just thinking of your commendation that you maintain all the age classes and species compositions. What if you might be able to eliminate middle-age clasess without any loss of species whatsoever, but if we reduce either ends; we might actually lose species. Is that possible?

Response by Mr. Telfer: That's right, we could. Although most of them are quite flexible, with the exception of some. There is obviously some physical limitation for pileated woodpeckers needing big trees, but it does seem that there is a lot of birds associated with this young stage, a lot associated with the mature and old stage and, the mid-stage is kind of a meeting ground. If you had an area, for example, a park where you kept fire out, and you didn't cut anything, and left the thing until all the young forest was gone, you would lose quite a few species. The same way with a logging area, if we systematically remove all that old forest, again you are going to lose species.

Question by Mr. Fitzsimmons: I wonder if some of the fire cycles that you reported are actually fire intervals where not all fires are stand-replacing fires. You mentioned that 15 percent of areas are missed within a fire, and 15 percent of these areas are burned with low enough intensity that their stands are not replaced. I am just wondering, whether the definition you use of fire cycle includes, for example, in a lodgepole pine forest a fire that might go through and not replace the stand? My second question is I wonder if you looked at, or if anybody has looked at patch size of the forests, and how that has changed from prehistoric times to now? If you increase the patchiness of your environment, do you provide less habitat for, the forest interior species? I wonder if anyone has looked at that sort of question.

Response by Mr. Telfer: Well, that is an important point. I think that your first question, the fire cycle is defined as the length of time it takes for an area to be burned; the sum total of the area within the perimeters of all the fires to equal the regional area. Obviously there could be lightly-burned areas. In the boreal, most burns are pretty intense and clean, but you do have these skipped patches. There are some areas where you get ground fires that wouldn't kill all the trees. This would again make the patch size smaller as the final result. The second question, I looked to some statistics on fire size in Alberta. These were statistics between 1918 and 1950, a period when they were keeping some reasonable information on fire size, but before fire suppression was frightfully effective when we got away from the settlements. There was a weighted mean fire area of 434 hectares that I come up with. That obviously is a very wild figure, but it gives an idea that, a whole lot of fires burn very little area. You get a few middle-sized fires, but most of the area is burned by a few huge fires. Therefore, you get a negative exponential type of distribution. Stop and think about it, suppose you have a country that is nicely divided up into 434 hectare blocks. Forty years down the road, another fire will burn through there and maybe take out half of that 434 hectares and reduce them again to the young-age class. Maybe another 60 years on from the first fire, another fire burns across both those patches. You get lakes and muskegs, you get rock-out crops, making fire breaks and creating fire shadows, and in this landscape, the burn patches are going to be much smaller. In fact, there was one fairly big study in northern Manitoba of a caribou winter range. They estimated the patch size at about four hectares, ten acres. That is a pretty small patch size. For different types of vegetation, I think of small patch sizes as being characteristic, but in the size was to some extent random. The ignition, fuel and weather has a degree of randomness about it. Look at it over a couple of millennia. You could have periods when there would be quite a group of patches together that would have been roughly the same age. If we go through some of the places where half of it burned in 1860 and the other half burned in 1875, it is all getting to be pretty old forests now — mature forest. The difference is not much, and you would have had such accidental groupings that would be large enough for territories of birds like pileated woodpeckers. Some people speculate that goshawks also need this kind of extensive mature and over-mature forest, so that would be the situation.

Comment by Mr. Jessup: Ed, you were talking about snags at the end, and I was hoping that you didn't think that fires were the only thing that created snags. In Saskatchewan before the Green movement, the fur traders would take 100 000 beavers a year. Last year, they only took 8 000, so next year, we are going to have 92 000 beavers out here creating snags all over the place for flooding timber.

Comment by Mr. Telfer: True, we have many things that create snags.

SESSION 2

STATE OF KNOWLEDGE OF IMPACTS OF FOREST MANAGEMENT OF BIRDS IN THE BOREAL FOREST

Chair: Jean-Pierre Savard
Canadian Wildlife Service
Sainte-Foy, Quebec

BIRDS AND BOREAL FORESTS IN ONTARIO

Dan Welsh
Canadian Wildlife Service, Nepean, Ontario

ABSTRACT

Birds of the boreal forest have evolved in parallel with the landscape. Concerns about the impacts of forestry must be precisely articulated to ensure that their conservation needs are integrated into forest land management plans. Forest ecosystem classification systems are suggested as a possible tool to improving integrated forest wildlife management because they allow standard habitat description. Distribution patterns of selected bird species in relation to the Northwestern Ontario Forest Ecosystem Classification demonstrate promise for the approach. The abundance of selected bird species in relation to forest stand age also has distinct patterns. Minimally, a sound forest conservation strategy should ensure the continued supply of all types and ages of forest stands.

Our workshop is directed to integrated management of forests and conservation of biodiversity, in this case, boreal birds. The boreal forest is a catastrophe driven forest with a high turnover rate. Although the rates vary at different locations and in different forest cover types, it is dominated by short-lived tree species and frequent disturbance.

The bird species of the boreal forest have evolved with the changing landscapes, and they have coped with change. We find patterns of habitat use at a regional level are different in one area compared to another, if species with national boreal range distribution are examined. They are clearly adaptable. Species that capitalize on young stands (i.e., less than five or ten years of age), are used to moving quite often, as their preferred habitats are ephemeral. Species living in mature forests and over-mature forests have the same habitat available for much longer, but they also must have the ability to disperse.

To deal effectively with concerns we need ways of describing the landscape that we can all agree upon (i.e., descriptions that are relevant for both trees and birds). Landscape ecologists define these aspects of the landscape: quality, quantity, and context. Actual forest stand composition attributes are the quality feature. The amount of the forest type on the landscape is the quantity aspect. The context attribute is what the forest stand type is next to and how the stands are connected to each other. I would like to share my concerns about bird populations and forestry; remembering that birds are adaptable and capable of moving from one habitat to another as they become available in a dynamic landscape.

We frequently hear about habitat loss. Habitats change after forest cutting and fire, but unless the land is turned into agriculture or suburbs this is just a part of the successional cycle. Change shouldn't be a concern unless the new forest is different than the old forest, or that we change the forest at a rate different from the rate that natural perturbations change the forests. Are we afraid that proportions of different forest types are going to change? Are some habitats going to become rare? Have they dropped below a critical level for adequate colonization? Are some species associated with certain habitats them going to become so uncommon that they are subject to extinction? It is important that we try to be specific about problems we have, and that they are phrased in terms of testable hypotheses.

We need to have a common language. For example, we all understood Malcolm Hunter when he talked about genetic aspects of biodiversity, but on the subject of ecosystems everyone had different ideas. The subject of ecosystems has problems trying to develop a common language. Discussions between foresters and biologists confirm these problems. For example, the biologist has finished on analysis with multivariate features, but the forester is talking about forest working groups. They are not talking about the same habitats in a meaningful way.

This paper is about landscape description and the aspects of quality, quantity and context. I will deal with aspects of quality such as the type of forest on the land base and the age of the forest, and how those factors relate to birds. One of the requirements within any resource management problem is having a solid information base about the resource described in terms of a common language. Where are forests in time and space, and where is wildlife in time and space, and how predictable are those things?

Forest Ecosystem Classification

A Landsat photograph of Ontario boreal forest would show that the forest is a mosaic composed of a variety of different types of forest stands of different ages and sizes. Forest ecosystem classification is an approach to providing standardized procedures for naming and describing forest stands. Systems exist throughout much of Canada including British Columbia, northwestern Alberta, Ontario, New Brunswick, and Newfoundland.

The example used in this paper is the Forest Ecosystem Classification for Northwestern Ontario (Sims et al. 1990). The system deals only with mature forest and 38 distinct forest types are identified. The relationship of these types to each other is shown in Figure 1, a two-dimensional ordination with axis reflecting moisture and richness gradients. Sites in the lower left corner are poor and wet, and those in the top right corner are rich and dry. Figure 2 shows the same information with tree distribution superimposed indicating black spruce in the left side and pine in the drier top side. Similar sites in both figures are closest to each other.

The Ontario Ministry of Natural Resources (OMNR) developed this classification as a silvicultural tool to: 1) manage the forest land base, 2) understand how to manage sites better, and 3) understand silvicultural considerations in treating sites and in growing new trees. The question asked was: Is that classification a useful means of describing forest habitat types for wildlife as an alternative to creating an independent wildlife habitat classification system?

Avian Diversity and Forest Ecosystem Types

Out of a total of 170 bird species breeding in northern Ontario more than half of them breed in the boreal forest. Forty percent are long-distant migrants that winter in the topics; 30% are short-distance migrants that spend the winter somewhere in continental North America; and the rest are residents and nomads.

In 1989 the Canadian Wildlife Service (CWS) and OMNR sampled breeding birds at 700 stations in northwestern Ontario and classified the forest ecosystem at each of those stations. The Forest Ecosystem Classification was used as a template and Figure 3 shows the abundance of selected bird species superimposed on Figure 1. The figure demonstrates a basic phenomena that is critical to understanding wildlife in the boreal forest; species occur unevenly among forest types showing predictable preferences and changes in abundance for different forest or 'habitat' types. Some species like the Connecticut warbler breed on organic soils with pure black spruce, while the veery occurs on well-drained sites dominated by trembling aspen. Regional habitat associations of the Connecticut

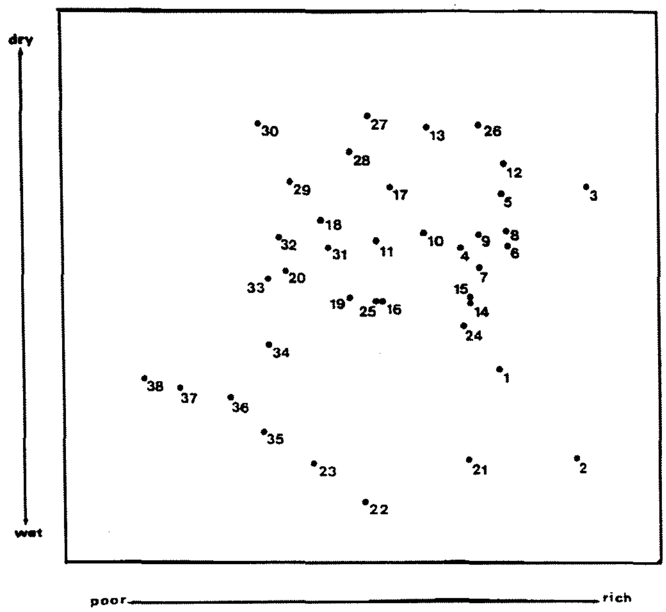

Figure 1. The relationship of 38 forest ecosystems to each other [from Forest Ecosystem Classification for Northwestern Ontario [(Sims *et al.* 1990)].

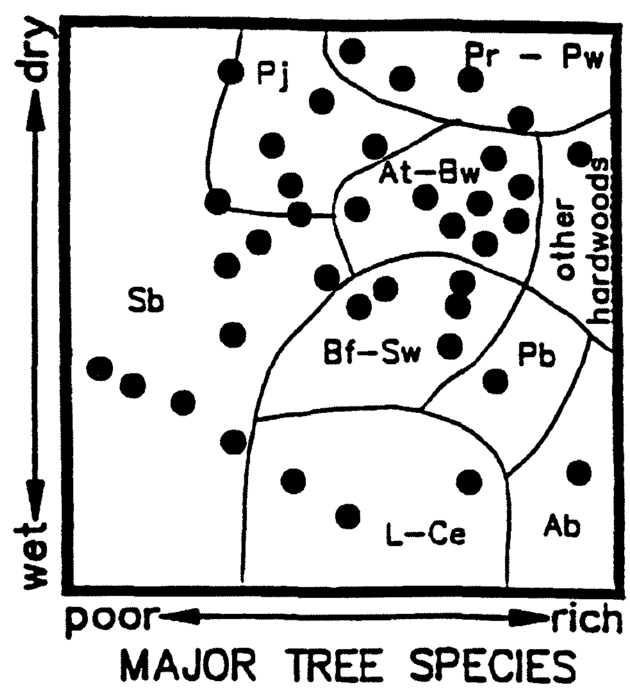

Figure 2. Distribution of tree species in the 38 forest ecosystems of Figure 1 superimposed on Figure 1. Species codes are: Pj=jack pine; Pr=red pine; Pw=eastern white pine; At= trembling aspen; Bw =white birch; Sb=black spruce; Bf=balsam fir; Sw=white spruce; Pb=balsam poplar; L=larch sp.; Ce=eastern white cedar; Ab=black ash.

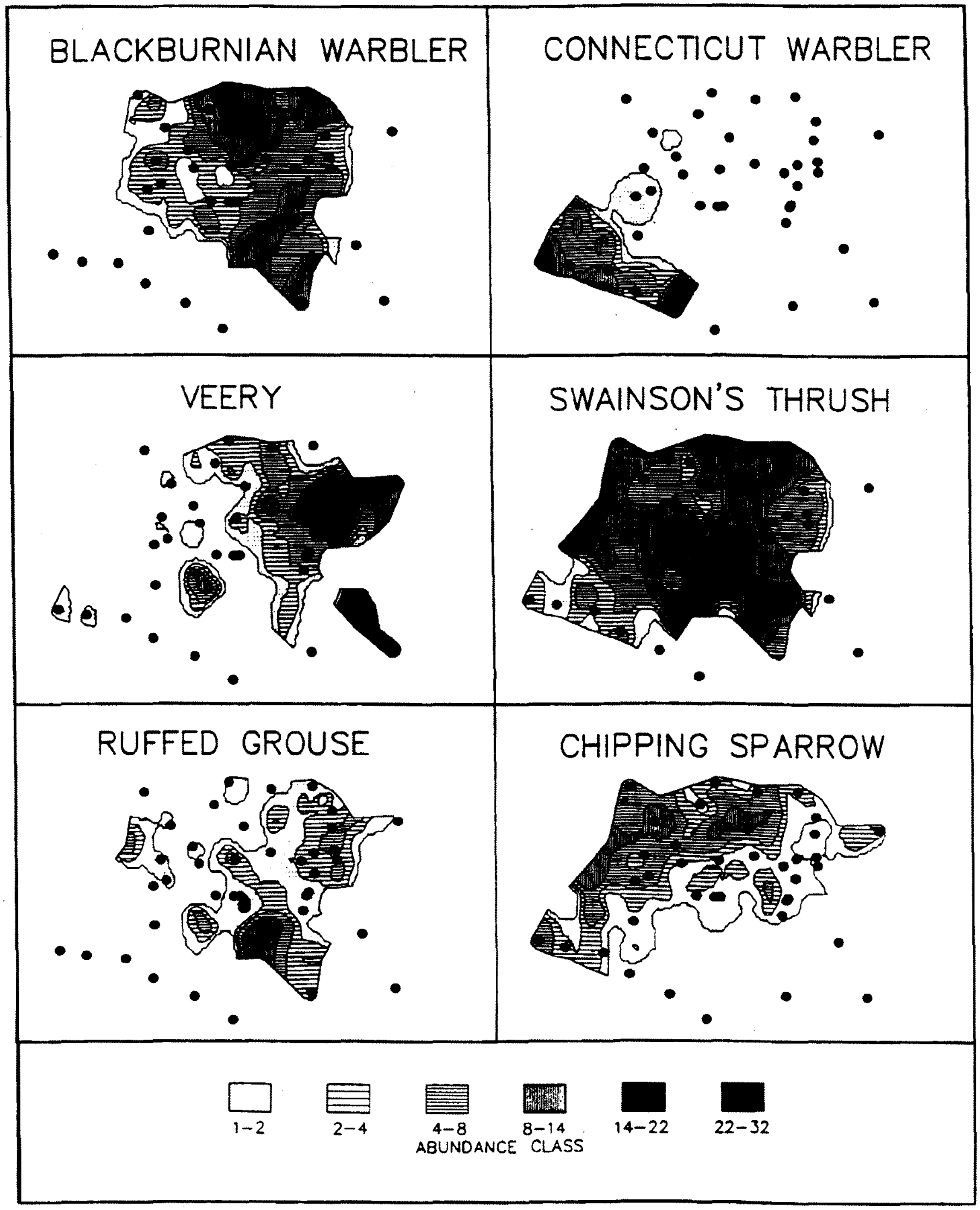

Figure 3. Bird species abundance patterns in relation to the 38 forest stand types. The large dots indicate the position of the forest ecosystem types.

warbler in Ontario are different from those in Saskatchewan. Swainson's thrush occur broadly, but are more abundant on some sites than others. Blackburnian warblers are widespread except in pure spruce and pure hardwood forest, but are only abundant in stands associated with red and white pine.

Birds are illustrative of the biodiversity conservation challenge in this example. We must direct our efforts to maintaining the continuing existence or supply of all of the major forest types in perpetuity, if we want to conserve the diversity of species.

Avian Diversity and Forest Succession

The second part of this paper deals briefly with aspects of temporal change. Ontario clear-cuts look like clear-cuts in other areas. Different perceptions depend on whether a clear-cut is the remains of an old forest or the start of a new forest.

Distinguishing between sites disturbed by man and natural sites (i.e., to distinguish between burns and cutovers) becomes more difficult as stands get older.. Often the only basis for stating their origin as stands become older is that we happen to know their history. Examples of burns and cutovers that are functionally identical have range of different forest types in both. From 1979 to 1983 CWS conducted studies on the relationship of forest birds to the age of the stand following cutting of mixedwood forests near Manitouwadge, Ontario. Some of these patterns are illustrated in Figure 4 in which the horizontal-axis is the age from cuts less than one year to old-mature forest more than 200 years old. The vertical axis is the relative abundance of the species. Some species are concentrated in young stands, others in mid-successional stages and some in mature forest, and others associate with micro-habitat features that are not age dependant. We need to continue to provide a range of different ages or temporal stages of forest stands if we want to conserve the diversity of birds and all wildlife.

Looking at the distribution pattern of individual species, it is clear that alder flycatchers, chestnut-sided warblers and mourning warblers are early-succession species. Red-eyed vireos and black-and-white warblers are mid-successional species in mixedwood stands. The late-successional species like golden-crowned kinglets, bay-breasted warblers show a strong skewed distribution to older stands on the right. Several species in relation to forest ecosystem types showed strong preferences to ecosystem. Magnolia warblers, ruffed grouse, and Canada warblers focus on micro-habitat features and not on any particular age of forest.

We have to work hard at developing a common language of landscape description for all participants in the challenge of managing Canada's forest land. The importance of conservation strategies that keep all of the temporal stages of a full range of forest ecosystem types is captured in Aldo Leopold's (1948) quote "The last word in ignorance is the man who says of an animal or plant: 'What good is it?' If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep very cog and wheel is the first precaution of intelligent tinkering."

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DISCUSSION

Question by Mr. Savard: What you have presented is the mature forest density of birds. The succession pattern within those forests as you go from clear-cuts or burns to the mature stage must differ between the various types. How

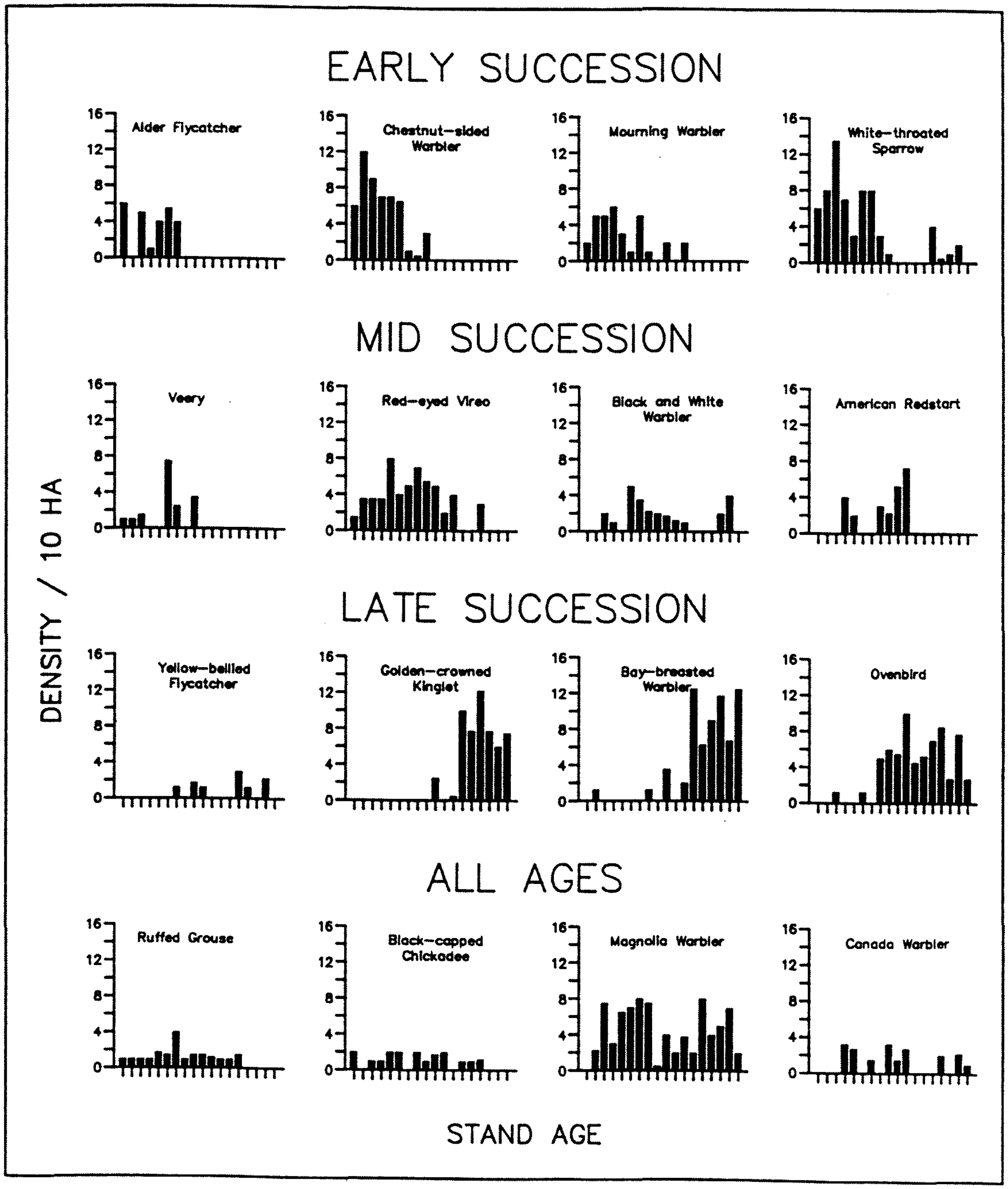

Figure 4. Bird species abundance patterns in relation to forest stand age. Stand ages from left to right are 1,3,5,6,8,12,14,18,21,23,27,33,57,110,145,150,200 & 220 years.

is your map going to change, or is the breadth of some species going to be shrunk?

Response by Mr. Welsh: I think there is a fundamental flaw in trying to present things two ways. I only took two slices of that habitat quality aspect. Let's look at mature forests only, and let's look at temporal variation. What I didn't in fact do is to treat those two items in a three-dimensional basis, and see how they feed into each other. That is what is really important. I think if we were to imagine our two-dimensional ordination, and then imagine a third axis of time coming out on that, then we can imagine species moving through that three-dimensional phase. It is only when we have our models functioning in that way that we can relate the temporal stage to where the forest stand is going that we can really start to have sound, predictive models. What we need to be able to do is to understand where any piece of the land base is going over time, so yours is a critical point. What has to be done is to match the first part of the talk with the second part, and put the second part at 90 degrees to it. In fact we see a temporal axis as a third axis. We are certainly trying to do that with some success, but it gets quite messy conceptually. Perhaps some people might see this as already being formidably, if not unnecessarily, complex.

Question by Mr. Fitzsimmons: I have got a question, is there a fairly solid relationship between the density of these birds and their reproductive success. If not, how do we begin to move on from just looking at where these birds are distributed, and where they are actually successfully producing young?

Response by Mr. Welsh: I guess it depends on what you consider as fairly sound. It is probably one of the most fundamental questions that should be asked of what I am doing. For those of you who aren't quite sure of the intent of the question, I am using abundance as a measure of habitat quality. All of my nice little coloured figures would lead you to believe that the areas where the species are abundant are somehow better for the species. That implication persists throughout the literature. There is some substantiation of it in a small number of species where we know in fact where the species are most abundant: the source situations. In fact they do better there, and I think as a generalization, it is probably safe enough, but we have to be very cautious. Raymond O'Connor's work on mistle thrushes from their low period in the early '60s quite clearly shows us that as the population goes from very low levels to very high levels, the validity of the assumption changes quite a bit through the expanding stages. When they reach superabundant states, it gets a little bit messier, because of problems of supersaturation of non-breeding birds in sub-optimal habitats. In general with the exception of a couple of the European thrushes in England and in Poland, there is very little evidence to suggest that it is a bad assumption on the whole. I am going to go with it for the time being, but we should all be very cautious about making that assumption.

Question by Mr. DesGranges: Dan, when it comes time to make conservation decisions; decisions for managing and things like that, you need to priorize things. Do you think you could use your data base on birds to distinguish the different types of bird communities that are worth preserving? The foresters have developed an ecosystem classification based on tree species which are found on sites. Would it be possible to do the same with your bird data, and recognize a certain number of ecosystems the way the birds are seen?

Response by Mr. Welsh: In fact, we have done quite a bit of work using very similar analytical techniques in putting together bird community types. From a point of view of conservation recommendations, I think that there is an inherent conservation recommendation in following the route that I have followed. That is, I think, relatively clear documentation of the need to use the coarse-filter approach, as Mac described. Try to keep all of the pieces in some sort of reasonable supply; I think Ed said in approximately the supply that we would expect them to occur in naturally. That would be my fundamental conservation recommendation, to try to keep a continuing supply of all of them in perpetuity. If we wanted to further strengthen that by looking at bird communities rather than looking at forest ecosystems, we could certainly do that. That does allow us to establish priorities for certain ecosystems. In mature forest types in northwestern Ontario, there is a fairly large amount of overlap through the central area. As you move out into the uncommon sites, (pure conifer sites and the pure hardwood sites) those tend to have more unique species associated with them. You can be reasonably safe and general when managing the middle bits. We can learn a lot more by looking at the bird communities. What we would learn is that going around the outside is a good starting point. The details of that are really another story, but it is something we are looking at, and it is a very good suggestion.

Question by Mr. Thomas: I am wondering if your ordination scales were strictly based on qualitative evaluations or partly quantitative?

Response by Mr. Welsh: I couldn't quite decide whether to get into a little bit more of the detail of what I was doing. I know I have frustrated a number of you by not doing so. The basis of the forest ecosystem classification ordination is based on Cornell Ecology Programs, principally the Twinspan and the Decorana Programs. The axis in the Decorana Program is one that by doing some standardization essentially ends up being species turnover units. There are about two major orders of turnover. The axis gradients run up to the 400 units, so there is a Decorana type of scaling that is associated with it. All I have done for the bird data was to take the X-Y coordinates for my sites based on their type of FEC classification and superimpose them. I didn't have to make any decisions at all about scale for the bird observations, but in fact just superimposed over. Through the use of a geographic information systems package that we are using called Spans, I was able to generate some maps to in fact fit their ordination. Their ordination is a Decorana ordination.

DECISION SUPPORT SYSTEMS FOR FOREST BIRD HABITAT MANAGEMENT

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ABSTRACT

This paper describes the current state-of-the-art of computer-assisted Decision Support Systems for integrated management of timber and forest birds in Canada. Modelling tools are being developed to forecast supply of habitat and timber within an integrated management system. Forecasts are needed to assist with developing management goals, objectives, and strategies. Research needs to support the process are reviewed.

INTRODUCTION

A Decision Support System (DSS) is designed to improve the ability of decision-makers to make high quality decisions quickly and easily (Morrison and Kurz 1991). A DSS is a tool or process to help a user select appropriate management activities. When linked to quantitative tools such as expert systems or Geographic Information Systems (GIS), DSSs support gaming in an interactive environment. Users can play "what if" games, to make forecasts of the impacts of alternative scenarios without actually doing anything in the forest.

A DSS can manage large amounts of information, accommodate complex systems, support logical and sequential planning processes, and use feedback loops to improve management systems. These features make DSSs attractive for integrated management of timber and forest birds. This paper provides a general review of Canadian timber/wildlife DSS development and status with examples from the Weldwood Hinton project.

INTEGRATED RESOURCE MANAGEMENT PRINCIPLES

Integrated Resource Management (IRM) can be described as simultaneous consideration of multiple management perspectives; at the same level, considering inter-dependencies between perspectives. Baskerville (1991) described five broad management steps required for successful integrated forest management: 1) make realistic forecasts; 2) choose the most appropriate forecast as a management goal; 3) implement planned actions at the times and places and with the strength outlined in the forecast; 4) assess the real system to determine where and how its dynamics differ from the forecast; and 5) return to step one using the knowledge gained in the management attempt.

Realistic forecasts require inventory data and forecasting tools to predict the effects of management actions. A DSS organizes data and provides the tools to make forecasts.

INVENTORY

Most of the managed forests in Canada have some form of timber inventory available, sometimes in GIS-compatible digital format. Unfortunately, timber inventories usually do not provide enough information to adequately describe forest bird habitats. This is changing - some current inventory specifications such as the Alberta Vegetation Inventory (Lakusta 1993) provide additional habitat description data. In some areas, habitat inventory is available, but often it is not compatible with the timber inventory.

Ecosystem inventory is rarely available in mapped format, and successional stage has such a large influence on bird communities that ecosystem inventories by themselves are probably not suitable for making forecasts.

Inventory and related information for forest bird species and communities is poor. Even basic species distribution and habitat association knowledge is usually not available. Density information related to habitat suitability is almost non-existent. Beyond general anecdotal accounts, we know little about many species.

A major problem with existing inventory is the purpose for which it was obtained. Managers were not thinking of forest birds when timber inventory specifications were designed. In addition, habitat and species information is often difficult and expensive to collect, and there was no recognized need for the information. Although needs are being identified through developing DSS processes, inventory is likely to lag behind requirements for many years. Groups such as the Canadian Forest Inventory Committee are pioneering integrated resource inventories designed to fill identified information needs in management systems.

FORECASTS

The tools to make realistic forecasts are the heart of a forest DSS. In simple terms, forest planning models abstract reality into a system model, solve to generate abstract solutions, and translate solutions back to reality. Forest DSS forecast requirements include inventory, spatial database management tools, models to predict forest structure in response to management alternatives, and models to predict supply of forest products (e.g., timber and habitat). DSS users make the forecasts and generate management objectives.

Although good spatial database management tools like GIS are becoming widely available, applications that can forecast changes to forest attributes in relation to management activities are mostly related to timber models (e.g., FORPLAN, Johnson and Stuart 1986; TimberRam, Price and Wrangler 1990; ATAMO, Walker 1990). Timber models from forest to stand level are now widely used in Canada. More recently, spatial timber analysis models such as HSG (Moore and Lockwood 1990) and GIS-FORMAN (Baskent 1990) have been developed to take advantage of the geo-referencing capabilities of a GIS.

Traditional methods for integrating timber and wildlife management were based on constraints against timber management objectives (Bonar 1989). Comparatively recent advances in computer resource modelling offer promising alternatives to traditional IRM processes. In particular, Habitat Supply Modelling (HSM) is both a quantitative and qualitative tool to assist with developing IRM objectives and strategies. Most advancements in HSM came after the 1984 symposium Wildlife 2000: Modelling Habitat Relationships of Terrestrial Vertebrates (Verner *et al.* 1986). A review of HSM concepts is provided in Norton *et al.* (1992).

A timber/wildlife DSS that links timber and habitat models must be integrated to be successful. Habitat supply models must be driven by the same forest inventory projection used for planning timber management. HSM can be non-spatial or spatial and can be linked to non-spatial or spatial population models.

Non-spatial habitat models estimate habitat supply through time within a defined area. They do not show the spatial location of habitat, and are not suitable for species with large home range or species that use habitat mosaics with defined spatial arrangements.

Examples are the CRITTERS and WILD WEASEL programs developed in Alberta (Beck 1990, 1992). Non-spatial population models estimate habitat supply and wildlife population dynamics through time within a defined area.

Spatial habitat models estimate geo-referenced habitat supply through time and space within a defined area. They can be used to examine habitat adjacency relationships and systems. Spatial population models add population dynamics capability, which is useful because populations may not respond immediately to habitat changes, and are influenced by external factors unrelated to habitat.

Canadian initiatives to link timber and wildlife habitat management planning through HSM are underway in at least six provinces, including Alberta (Bonar *et al.* 1990; Bonar 1992), British Columbia (Eng and Hoffos 1992), Manitoba (Manitoba Forestry/Wildlife Project 1991), New Brunswick (Sullivan *et al.* 1990; New Brunswick Fish and Wildlife Branch 1991), Ontario (Watt 1990; Duinker *et al.* 1991), and Saskatchewan (Terrestrial and Aquatic Environmental Managers Ltd. and Saskatchewan Wildlife Branch 1991). Reviews of current projects are provided in Greig *et al.* (1991) and papers from Wildfor 91 (Canadian Pulp and Paper Association and Canadian Society of Environmental Biologists 1992).

Integrated forest management planning DSSs are the most recent trend in forecasting. Examples include TEAMS (Covington *et al.* 1988), the NAIA project (NAIA Project Proposal 1990), the Northeast Decision Model (Marquis 1991), and the Forestry Canada Mixedwood DSS (Morisson and Kurz 1990).

FOREST BIRD HABITAT MODELS

Bird species and species groups are usually selected for modelling through one or more logical and hierarchical systems designed to represent entire bird communities. Approaches in use include featured species, indicator species, guilds, and life forms. Current Canadian HSM initiatives directed at individual species and models are usually based on the Habitat Suitability Index (HSI) developed by the United States Fish and Wildlife Service (USFWS 1981). HSI models assume a habitat for a species can be rated from zero (not suitable) to one (optimum). More than 150 models have been published by the USFWS (Schroeder 1990), and many others have been developed by others using the HSI criteria.

HSI models are routinely modified to reflect local conditions or available inventory information (Schamberger and O'Neil 1986; O'Neil *et al.* 1988). For example, the USFWS model for ruffed grouse (Cade and Sousa 1985) requires information about the average radius of circles encompassing 20 male aspen trees. In Alberta, the USFWS model was modified to relate to aspen canopy closure, information available in existing inventories (Bonar *et al.* 1992 [1]).

Non-spatial habitat models, where suitability for all life requisites is estimated for each habitat, are useful only for species that do not depend on spatial habitat inter-dependencies. However, spatial information could be used to depict location for planning from forest level to operational and stand level.

In recent years, the USFWS has concentrated efforts on testing hypotheses of existing HSI models (Schroeder 1990). This

[1]Uupublished report, Weldwood & Alta. F/W Division. Preliminary habitat models for the Weldwood Hinton Forest Management Area.

process provides the real world link where abstract solutions are tested against reality. The process can also test cause and effect relationships between habitat suitability and population density, relationships between habitat area, distribution, and species viability, and inter-species/intra-species relationships.

GOALS AND OBJECTIVES

GIS-based timber and habitat models show promise as useful tools to make forecasts. In New Brunswick, joint forecasting for timber and two wildlife species (marten and white-tailed deer) is being used to revise forest management plans based on specified objectives. Other projects are still developing forecasting tools.

When forecasting tools are available, they can be used to develop joint timber and wildlife goals in a DSS. Specific objective statements of expected quantifiable results related to goals can then be developed. This is the decision stage of a DSS, where forecasts of expected results are linked to desired results. Management plans and strategies can follow from the objectives.

MONITORING AND ADAPTIVE MANAGEMENT

An implicit component of a DSS is a monitoring program to evaluate the effects of management activities against objectives. For forest birds, this means regular monitoring of populations and distribution to relate reality to abstract forecasts. Long-term inventory and monitoring programs will be required. Protocols for these programs will be needed soon. Evaluations are the basis of adaptive management, which uses learned experience to revise the management system. This process will be critical to integrated forest bird habitat management, because of the temporal scale of management activities. The long-term impact of management decisions can be predicted, but real impact will not be determined for many decades. The DSS must be continuously evaluated and adapted to modify goals and objectives to incorporate new information.

RESEARCH NEEDS

Managers are developing DSS tools to improve integrated forest management decisions. There is a rapidly developing need and opportunity for related research to answer questions related to the DSS process.

Inventory: Integrated vegetation inventories are replacing traditional timber inventories. Inventory protocols that improve habitat descriptions are needed. The Canadian Wildlife Service Forest Bird Program is rapidly becoming a standard for forest passerines. Complimentary standards are needed for non-passerine species.

Habitat and species associations: Species and species group association with specific habitat types or structural features is poorly understood. This basic descriptive research is urgently needed, especially for those species selected as management indicators. Direct application of this work can be directed to developing new habitat models and testing existing models.

Habitat/density relationships: Most habitat models assume there is a direct relationship between habitat quality and density. This assumption must be tested, with the eventual objective of linking habitat and population models into a comprehensive system.

Effects of structural diversity management on forest birds: Harvesting and silviculture activities are the largest sources of site-specific change to forest bird habitats. Research to identify bird responses to changes in structural diversity is needed to develop objectives for improvements to harvesting and silviculture practices.

Effects of landscape-level management on forest birds: This area includes fragmentation, reproductive success, landscape linkages, population viability and vulnerability, and biodiversity. There is a need for research at the landscape level and an urgent need for long-term monitoring and research.

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DISCUSSION

Question by Ms. Hannon: Where did you get the data on habitat requirements for various species to generate the habitat suitability?

Response by Mr. Bonar: We adapted the U.S. Fish and Wildlife Service models for our local situation, and for those that we couldn't find an existing model, we did a literature review, and came up with the first model based on the literature review.

Question by Ms. Hannon: Were most of the data from more eastern systems?

Response by Mr. Bonar: Yes. That is one of the problems with the existing models. A lot of them were developed under eastern systems or in southern systems. For example, the U.S. Fish and Wildlife Service pileated woodpecker model was primarily developed in the Pacific Northwest and Douglas fir ecosystems. If you take that model and try and apply it in a boreal forest, you should run out and tell all the pileated woodpeckers that they can't live there, because there are no trees big enough for them. You have to modify those models for the local situation.

Question by Mr. Pepper: Did you try to compare the habitat suitability models between species? When you try to look at five or six species, what kind of results did you find? Did you come to any conclusions?

Response by Mr. Bonar: We are dealing with 30 species in our management system, and we haven't got to the point where we have done much detailed analysis of habitat versus the actual models that we have. Are you asking if some models are better than others?

Question by Mr. Pepper: No. I have always wondered how the habitat suitability indices worked. Do you take them for all 30 species and try and throw them all together, and develop a management plan?

Response by Mr. Bonar: I see. How do you put all the pieces together? Yes, that is a challenge we haven't grasped yet. We started to set some individual species goals. We are going to need the other piece of the puzzle that was mentioned earlier, and that is the ecosystem supply analysis. We can't hang our hat on just the individual species habitat models because, in effect, that is the fine-filter approach without the coarse filter. We need the coarse-filter and the fine-filter. The coarse-filter approach is the supply of all of the ecosystem types, and then we can look at the individual species within it. It doesn't really matter to me whether you start with the species first, and then go to the ecosystems, or you start with the ecosystems and then move to the species. You will probably need both in the long run in. A decision support system, you can build rules that say, if you are dealing with species, that some species are more equal than others or that some species are more important in this area, and others are more important in another area. Then you can try and play games with what you would like to do with timber, and try and come up with some sort of a system that will balance all that off. That is a bottle of wax that we haven't got to yet.

BIRD ABUNDANCE IN SPRUCE FORESTS OF WEST CENTRAL ALBERTA: THE ROLE OF STAND AGE

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ABSTRACT

Integration of bird habitat requirements into forestry planning requires a basic understanding of bird distribution patterns. This study examined breeding songbird distributions associated with stand age in spruce dominated sites near Hinton, Alberta. Only four species out of 22 did not exhibit significant differences in population density among the three ages of forests sampled (35, 105, and greater than 180 years). Bird species that are most abundant in mature and old stands are at risk in view of the depletion of these age classes in regions managed primarily for fibre production.

INTRODUCTION

Boreal forest ecosystems are mosaics, with stand age being a major cause of variation in vegetation structure and composition (Rowe and Scotter 1973). Many forest birds respond to this variation with distribution and abundance patterns that reflect vegetation patterns, although few data are available for populations in boreal regions. Knowledge of bird distribution and abundance is a prerequisite to forest planning that effectively integrates bird habitat requirements with requirements for fibre production.

The purpose of this study was to document patterns of abundance of breeding songbird species among different aged spruce (*Picea* spp.) forests near Hinton, Alberta. Before intensive forestry operations began in this area in the mid 1950's, almost 30% of the 700,000 hectares of productive forest land was dominated by spruce, 50% by lodgepole pine (*Pinus contorta*), and the remainder mostly by hardwoods or recent reproduction (Reed *et al.* 1978). One third of the area was classified as overmature, and 40% was mature (56-75 years), (Reed *et al.* 1978). Harvesting of approximately 100,000 hectares since that time (Walker 1990) has focused on older successional stages, much of which is dominated by spruce. An understanding of bird distributions within spruce forests is therefore a first step towards ensuring the persistence of bird populations in this area. The information will be incorporated into models of habitat suitability and habitat supply (Bonar *et al.* 1990) for Weldwood's Hinton Forest Management Agreement (FMA) area.

METHODS

This study took place within the McLeod Working Circle of Weldwood's Hinton FMA area, south of Hinton, Alberta at approximately 53°N, 117°W, and at elevations between 1 200 and 1 500 metres. The study sites were within the upper boreal cordilleran and subalpine ecoregions described by Corns and Annas (1986). Coniferous to mixed coniferous-deciduous forests occur throughout the working circle, with dominant trees being lodgepole pine (*Pinus contorta*) and white spruce (*Picea glace*), with lesser amounts of black spruce (*Picea mariana*), subalpine fir (*Abies lasiocarpa*), and aspen poplar (*Populus tremuloides*).

Nine sites were studied; each approximately one square kilometre in area. All contained significant proportions of spruce in the overstorey. The three young sites were dominated by 35-year old cutblocks; the three mature sites originated by fire 95 to 115 years ago, and the three old sites originated by fire at least 180 years ago. Each contained 12 sample plots at which bird abundance and habitat characteristics were estimated. Plot centers were 300 metres apart. The sampling period was 15 May to 15 July, 1991, during which each site was visited four times. Sampling began one half hour before sunrise, and ended approximately 4.5 hours later.

The variable radius circular-plot method was used (Reynolds *et al.* 1980) to obtain estimates of bird density at each sample plot in a site. The number of each bird species seen or heard while remaining stationary at the plot centre for 10 minutes was recorded. The total number of individuals per plot was calculated as either twice the number of singing males, or the number of singing males plus all other observations, whichever was greatest (Reynolds *et al.* 1980). Estimates of effective detection distance were possible for species detected at least 30 times, and these estimates were used to determine effective sampling area for each species (Reynolds *et al.* 1980). The total number of individuals per plot, divided by the effective sampling area, gave an estimate of density, which was averaged for the four visits combined.

Kruskal-Wallis tests were used (Zar 1984) to determine if significant differences in population density existed among the three forest age classes. Density estimates for most species were markedly skewed towards low values, making parametric analyses inappropriate. Zar (1984) was followed to make multiple comparisons among mean densities for species with significant variation among age classes.

RESULTS

A total of 4 195 individual detections were made during all count periods combined. The territorial drumming calls of three-toed woodpeckers (*Picoides tridactylus*) and black-backed woodpeckers (*P. arcticus*) were not distinguishable from each other, and therefore the two were grouped as one species, (three-toed woodpecker). With this qualifier, 42 species were detected during at least one count period, with species richness at each site varying from 23 to 34 species. Species that were detected only as they flew over the plot (Canada goose, common snipe, osprey, common raven and American crow) were not included in the analysis. The number of plots in which a species was detected varied considerably, ranging from only a single plot (northern goshawk, black-capped chickadee and bohemian waxwing) to all 108 plots (yellow-rumped warbler).

Estimates of population density at each site were possible for 22 species (Figure 1). While the pattern of variation among sites was unique for each species, several tended to be more abundant in a particular forest age class. In fact, only four species did not exhibit significant differences in density among the three forest age classes (Table 1).

DISCUSSION

Previous studies have shown that the distribution and abundance of forest birds is correlated with vegetation patterns (James 1971; Bock *et al.* 1978; Ralph 1985). The strength of such associations varies widely among species, as does the scale at which they are evident (Weins 1981). Presumably, bird and vegetation associations are caused by variation in the availability of resources in different habitats, with possible roles of interspecific competition (Minot 1981), predation (Tomialojc and Profus 1977), brood parasitism (Brittingham and Temple 1983), and post glacial bird colonization patterns (Snyder 1950).

In this study, vegetation structure and composition differed considerably among sites (Farr 1992). For example, younger sites tended to have shorter tree canopies, and a greater

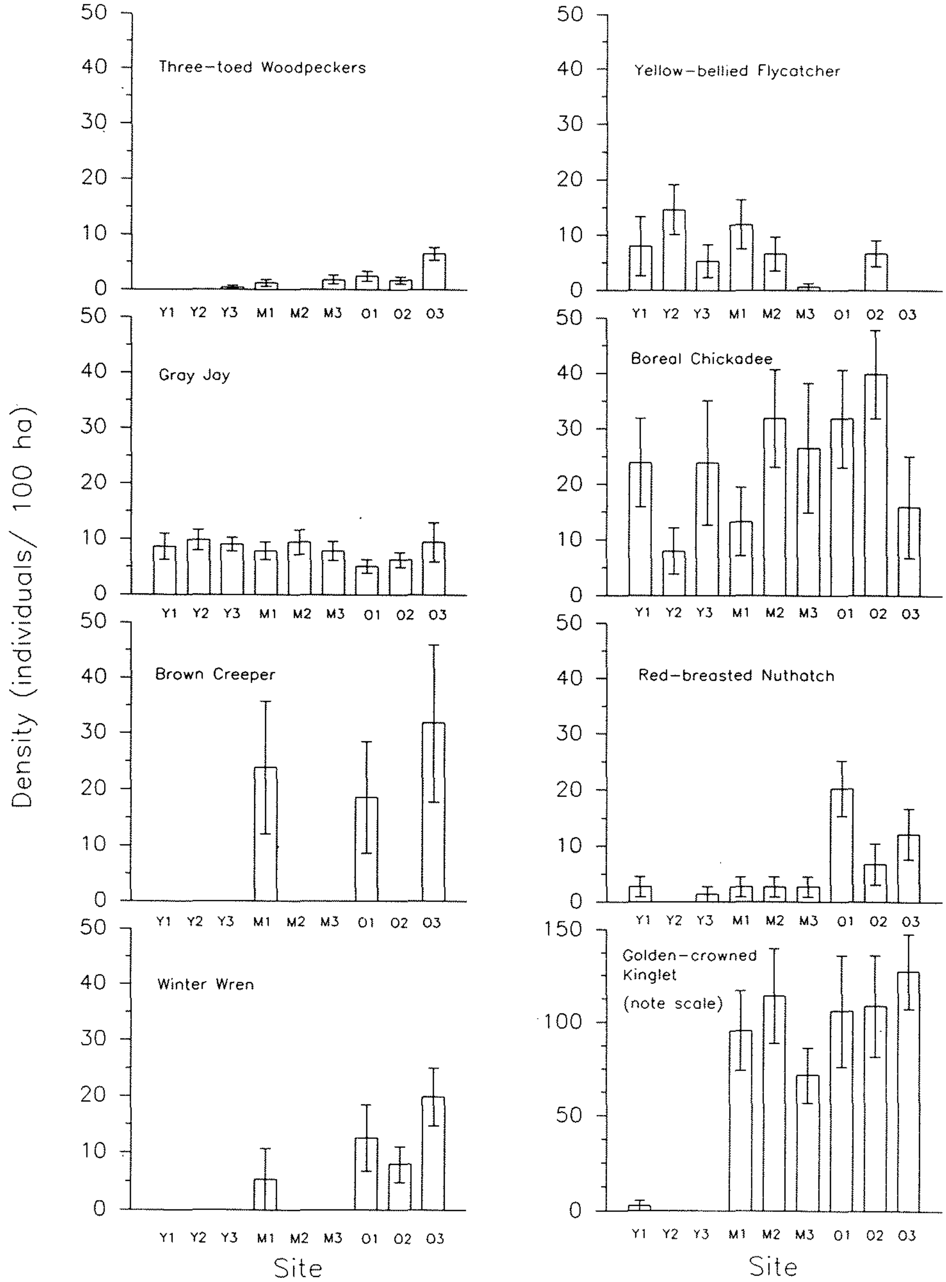

Figure 1. Population densities of 22 bird species at nine sites near Hinton.

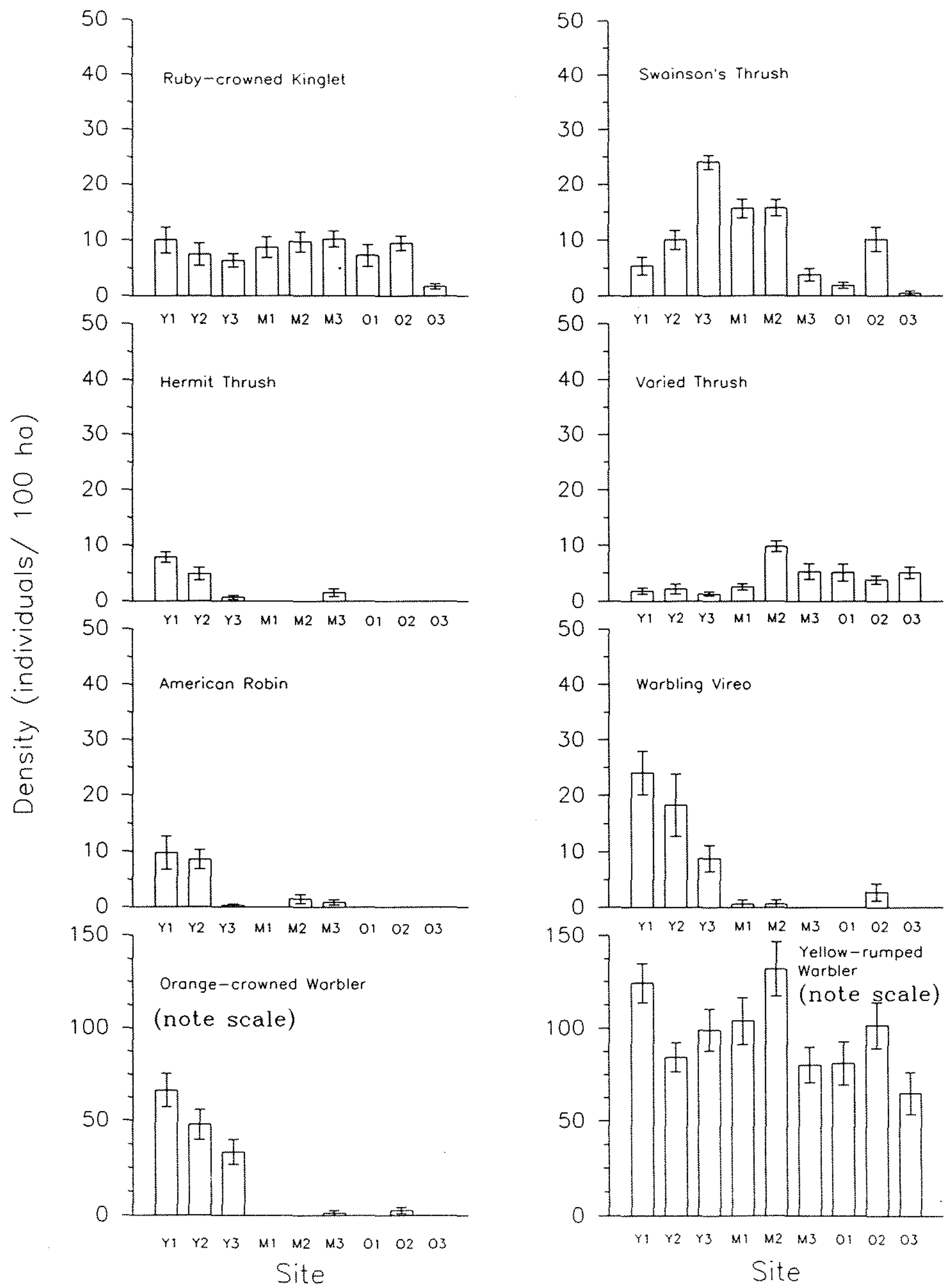

Figure 1. Population densities of 22 bird species at nine sites near Hinton (continued).

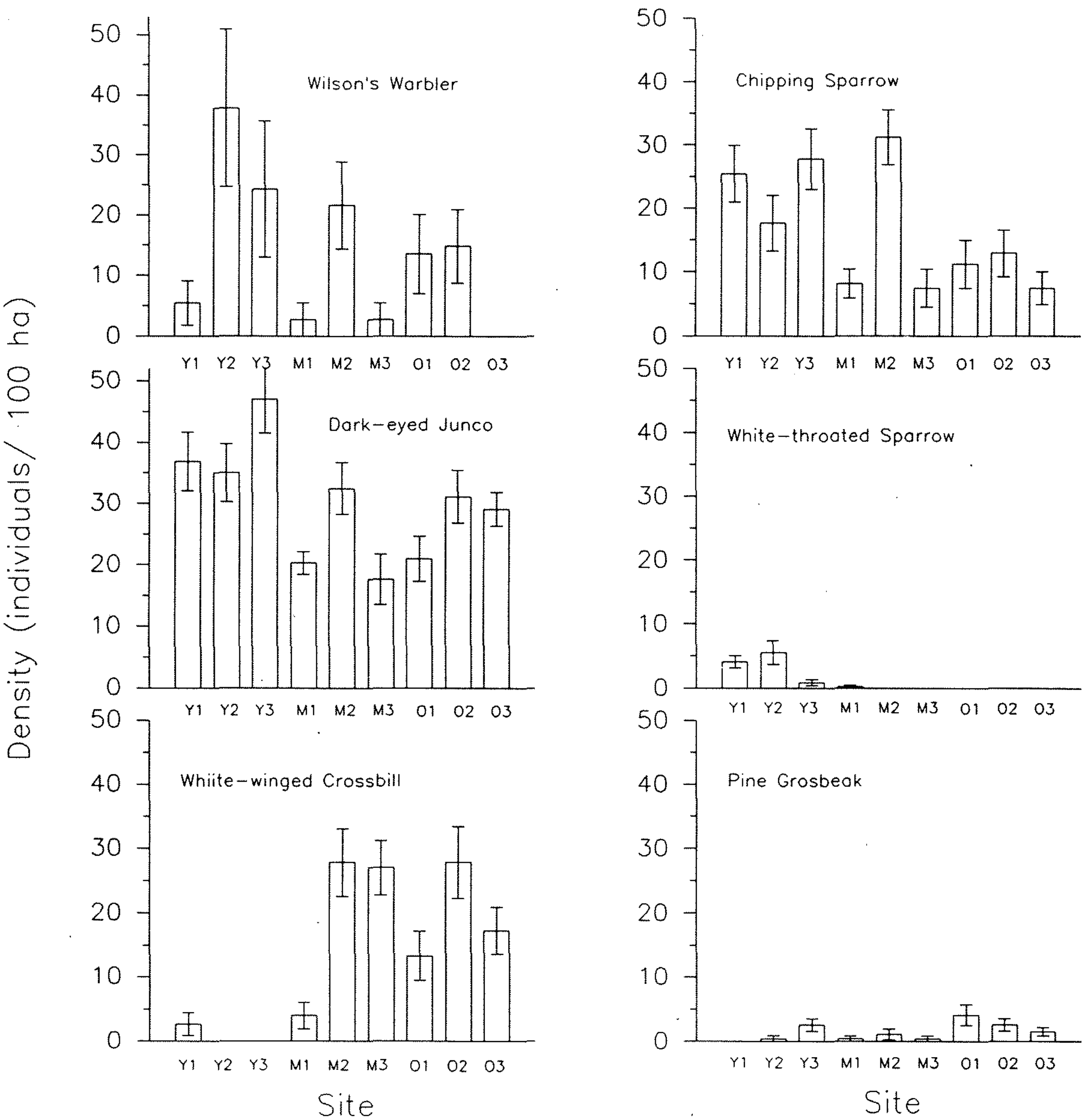

Figure 1. Population densities of 22 bird species at nine sites near Hinton (continued).

Table 1. Comparisons of bird densities among three age classes of spruce forests near Hinton. The sums of ranked densities in three age classes (Young, Mature, Old), with 36 plots per age class, were compared using Kruskal-Wallis tests with X^2 approximation; df=2 for all tests. Multiple comparisons among age classes were after Zar (1984:199); ">" indicates significant difference ($p<0.05$), "=" indicates no significant difference ($p>0.05$) between two age classes

Highest Densities in:	X^2	P	Comparisons
Young Sites			
Yellow-bellied Flycatcher	6.2	0.046	Y > M > O
Hermit Thrush	50.7	0.001	Y > M > O
American Robin	31.8	0.001	Y > M > O
Warbling Vireo	62.3	0.001	Y > (O = M)
Orange-crowned Warbler	80.0	0.001	Y > (M = O)
White-throated Sparrow	47.5	0.001	Y > (M = O)
Chipping Sparrow	13.7	0.001	Y > M > O
Dark-eyed Junco	16.9	0.001	Y > O > M
Young and Mature Sites			
Swainson's Thrush	24.7	0.001	(Y = M) > O
Yellow-rumped Warbler	6.1	0.047	(M = Y) > O
Mature Sites			
Varied Thrush	22.0	0.001	M > O > Y
Old and Mature Sites			
White-winged Crossbill	38.1	0.001	(O = M) > Y
Old Sites			
Three-toed Woodpecker	31.1	0.001	O > M > Y
Red-breasted Nuthatch	20.8	0.001	O > M > Y
Brown Creeper	7.5	0.023	O > M > Y
Winter Wren	40.1	0.001	O > (M = Y)
Golden-crowned Kinglet	54.0	0.001	O > M > Y
Pine Grosbeak	10.2	0.006	O > Y > M
No Difference			
Gray Jay	4.8	0.089	(Y = M = O)
Boreal Chickadee	2.9	0.235	(O = M = Y)
Ruby-crowned Kinglet	5.9	0.052	(M = Y = O)
Wilson's Warbler	3.4	0.179	(Y = O = M)

proportion of aspen in the overstorey. Differences in vegetation probably influence important factors such as resource availability, but identifying the factors that actually cause species abundance patterns is beyond the scope of this study. As Weins (1983) put it, "Discerning the patterns of natural systems and deriving process explanations for those patterns are separate, sequential phases of scientific activity".

Forests managed primarily for fibre production undergo regional changes in vegetation patterns; particularly the age class distribution of forest stands. Under intensive forest management, the age class distribution of a forest region becomes narrower if a large proportion of older stands are removed, and subsequently harvested before their annual growth declines. In fire controlled ecosystems, a larger portion of the stands in the region escape disturbance for periods longer than the optimum rotation for forestry. This is due to stochastic (random) and physiographic (e.g., aspect, local moisture regime) factors. A regional decline in the proportion of older forest stands is a major feature of landscapes managed primarily for fibre production.

Given the observed differences in bird abundance among different aged stands (Table 1), regional changes in bird distribution patterns are to be expected in intensively managed forests. In west central Alberta, bird species that reach their peak abundance in older stands (e.g., three-toed woodpecker, winter wren) face the greatest potential declines in supply of optimal habitat.

Management of future habitat suitability and supply should also consider meta-population structure (Levins 1970), given that sub-populations of many species within an area are surrounded by areas of unsuitable habitat. For example, most bird species within Weldwood's Hinton FMA area are patchily distributed, with varying population densities, and varying rates of exchange between sub-populations. Wiens (1981) suggested that reproductive output in "good" habitats can exceed local carrying capacity, with excess individuals dispersing to other areas. In "poor" habitats, reproduction may not be sufficient to maintain a population, and persistence may occur only through individuals colonizing from elsewhere. If this "source and sink" model of meta-population dynamics (Weins 1981) applies to forest bird species, then the take home message is that "good" habitats (probably areas with the highest population densities) may be critical for the long term persistence of a species. Excessive reduction in the supply of such areas, even if poorer quality habitats are plentiful, may result in regional extirpation.

In conclusion, long term, regional perspectives of boreal forest bird populations, and habitats are required in order to ensure their continued persistence in managed forest ecosystems.

ACKNOWLEDGEMENTS

This presentation was based on a larger study supported by several organizations, and the financial or logistical assistance of the following is gratefully acknowledged: Alberta Forestry, Lands and Wildlife (Fish and Wildlife Division, Forest Technology School); Canadian Circumpolar Institute of the University of Alberta; Canadian Wildlife Service; Department of Forest Science of the University of Alberta; Recreation, Parks and Wildlife Foundation; and Weldwood of Canada Limited (Hinton Division). In particular, I thank Rick Bonar, Richard Quinlan, and Ed Telfer for their support throughout this study.

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DISCUSSION

Question by Ms. Schmiegelow: I have a question and a comment. I notice for most of your charts that you were sampling just for one year. My caution there is that extrapolating abundance measures to reproductive success over one season may be very, very risky. If you have a temporal picture and it indicates that you have consistent abundances in cross-years in the same habitat, that may be reasonable to assume that you are getting a strong relationship with reproductive success. It is quite conceivable that within a given season, you may see high abundances in an area where there is not high reproductive success, if you follow the same sort of argument, and consider that a lot of the individuals in a higher abundance area may float into the population. I am saying that the more temporal data that we can find on these things, the more accurate the abundance.

Response by Mr. Farr: Yes, I agree. We need the temporal data. We also need the data that assess how good the correlation between abundance and reproductive success actually is. We need more of that.

USE OF EARLY SUCCESSIONAL, MID SUCCESSIONAL, AND OLD GROWTH FORESTS BY BREEDING BLUE GROUSE ON HARDWICKE ISLAND, B.C.

Joe F. Niederleitner
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ABSTRACT

Relative numbers of blue grouse (*Dendragapus obscurus fuliginosus*) in early successional stands of coastal western hemlock (*Tsuga heterophylla*) are higher in stands of early successional status than in old growth or mid successional stands. Numbers in the latter two cases are low and not significantly different. Coverage of the herbaceous layer may be of importance to breeding populations.

INTRODUCTION

In summer 1981 an analysis of the relative numbers of blue grouse was conducted in different forest successional seres in coastal British Columbia. Because most previous studies of blue grouse had been conducted in stands of early (0 to 25 years post- harvest) successional status (Bendell and Elliot 1966, 1967; Zwickel and Bendell 1972; Armleder 1980; Frandsen 1980) it was of interest to conduct a comparison of numbers in different successional seres. The objective of this study was to compare relative numbers of birds in differing successional stages and to conduct an analysis of the vegetation occurring in different seres. The work fulfilled the requirements of an honours research thesis.

STUDY AREA

The study area chosen was Hardwicke Island, B.C. (Figure 1). The island is characterized by relatively rugged topography, with elevations ranging from sea level to approximately 762 m. Logging has occurred on the island since the late 1800s, beginning at lower elevations and proceeding to higher elevations in later years. This has left a variety of residual stands with a corresponding variety of stand origins and associated ages. Old growth remains at higher elevations. Vegetation and climate on the island is that characterized by the Coastal Western Hemlock Zone (Taylor and McBride 1977).

METHODS

Selection of habitats and sampling

The ages of the most abundant tree species within stands was used to distinguish successional stage. These data were taken from forest inventory maps of Crown Forest Industries Ltd. (New Westminster, B.C.). Comparable stand sizes, slopes and exposures were desirable attributes among successional stages, although these conditions were not always satisfied. Table 1 summarizes these conditions and other attributes of habitats selected. Several of the selected stands were located in a study area with intensive ecological work, therefore other data were available for comparison.

Habitats were sampled with transects that were 1 km in length. These were used to conduct bird counts and to position plots for the vegetation analysis. Transects were positioned in the center of each selected stand, with four stands (therefore four transects) used to represent early succession, two transects to represent mid successional status and two transects to represent old growth.

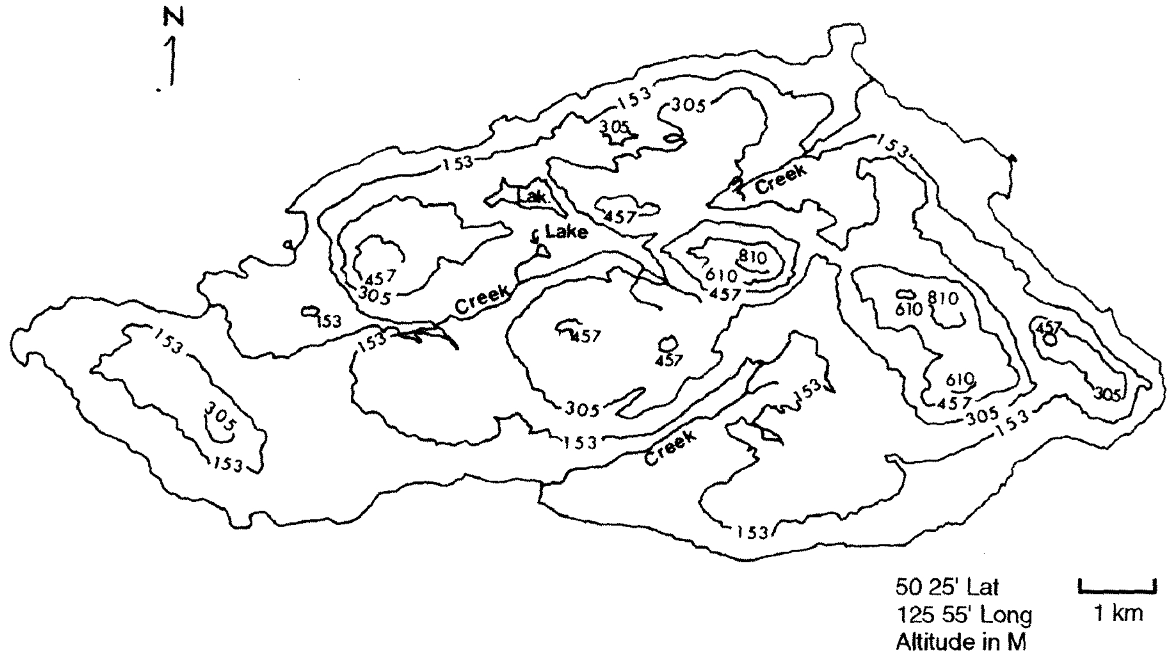

Figure 1. Hardwicke Island, British Columbia.

Table 1. Age, altitude, slope, and site quality class of the habitats on censused transects

Habitat	No. of transects	Age of stand (years)	Range in mean altitude (m)[a]	Range in mean slope (degrees)[a]	Site quality (range)[a]
Early successional	4	3-13	66-378	12-20	III-IV
Mid successional	2	59	84-97	13-16	III
Old-growth	2	251+	286-445	14-22	IV-VI

[a] Slopes and altitudes were taken at each listening station. Site quality class is a function of site index (Avery and Burkhart 1983). At 100 years of age, height of dominant and codominant trees are 56.3 m and greater in class I; 47.2-56.1 m in class II; 38.1-46.9m in class III; 29.0-37.8m in class IV; 19.8-26.7 in class V, and 10.7-19.5 m in class VI.

Vegetation analysis

Vegetation was characterized with the assistance of large circular plots (8 m in diameter) and four nested "Daubenmire rectangles". Larger plots were used to assess the coverage of vegetation in the tree layer (>2 m in height) and the shrub layer (1-2 m in height). Smaller plots were used to assess coverage in the herb layer (0.03-1 m) and the bryoid layer (0-0.03 m). Thirty composite plots (one circular plot with its inclusive Daubenmire rectangles) were established in each successional stage. Other details are described in Niederleitner (1987).

Counts of hooting males

The number of singing males was assessed utilizing an audio count. This involved counting the number of males audible from a series of equally spaced listening stations. Males were stimulated to hoot with a recorded tape playback of female reproductive calls ("whinny" and "cackle"). Counts were standardized by conducting them in the morning and evening at times respective of sunrise and sunset. Equal amounts of time were spent at each station and in transit between stations.

Weather permitting, four transects were surveyed per day, with two in the evening and two in the morning. The month of May was selected to do these counts as this is when males most frequently respond to tape playback (McNichol 1981). Singing males in associated territories were also located on foot to provide an additional check. These data are given in Table 2.

Counts of females with broods

Broods were detected along transects with the aid of a pointing dog. These counts were conducted mid-morning to mid-day during the months of June and July. June and July were chosen because most chicks hatch in the first week of June (Zwickel,unpublished data, 1981). In late July and August chicks are large enough to wander away from breeding areas. Counts were standardized with respect to sunrise and sunset, and the amount of time spent on transects was controlled on a per-distance basis. Transect counting sessions were terminated if time limits per unit distance were excessively exceeded due to unforeseeable circumstances. The presence of a brood was confirmed with the assistance of an imitated chick distress call, which elicited elements of the distraction display from hens.

Table 2. Numbers of individual hooting males identified from transects in May and June 1981

Habitat	No. of transects	Total no. of males	Mean no. males/transect[a]
Early successional	4	36	9(3-16)
Mid successional	2	1	1(0-1)
Old-growth	2	1	1(0-1)

[a] Ranges are in parentheses

Table 3. Species richness and mean percent cover of early successional, mid successional, and old growth habitats on Hardwicke Island, British Columbia

Strata	Early successional		Mid successional		Old growth	
	No. of spp.[a]	Mean % cover, all spp. combined	No of spp.[a]	Mean % cover, all spp. combined	No. of spp.[a]	Mean % cover, all spp. combined
Bryoid	26	33.3	14	27.5	12	45.8
Herb	32	44.5	13	5.8	3	10.1
Shrub	15	21.4	10	7.5	5	5.0
Tree	9	9.9	8	93.4	6	91.2
Litter, slash		31.2		18.4		6.4

[a] Bryophytes and grasses are combined as respective groups rather than as species

RESULTS AND DISCUSSION

Vegetation

Table 3 summarizes the character of the vegetation encountered along transects. In general, the vegetation of early successional habitats was characterized by diversity and higher coverages in the lower height strata (bryoid, herb and shrub layers), with restricted development of vegetation in the tree layers. Two early successional stands had extensive slash accumulation.

Mid successional and old growth stands had high coverages in the tree layers with a more restricted development of the understory. One mid successional stand was particularly barren, with an absence of herbs and shrubs and only scanty coverages in the moss stratum. The other stand, however, had better development in the lower vegetation in association with canopy gaps and deciduous canopy component. Better development of the understory in association with canopy gaps also occurred in old growth habitats. There was considerable development of salal (*Gaultheria shallon*) coverage in one case.

Bird counts

Grouse count results are depicted in Figures 2 and 3. Results are highly significant (95% level of confidence, Kruskal-Wallis test), indicating that the relative numbers of birds found were higher in early successional habitats. These results concur with Table 2, which describes number of individual hooting males on territories. These were located on foot. There was some variability in the results for early successional habitats, however, two clear-cut habitats with restricted vegetation development and high slash accumulations had lower bird counts. On numerous occasions, broods in the later successional seres were found in association with gap vegetation complexes. During casual observations, one brood was also located in a recently thinned immature stand. It is therefore hypothesized that development of the herb layer (see previous definition) may be of importance to coastal races of blue grouse.

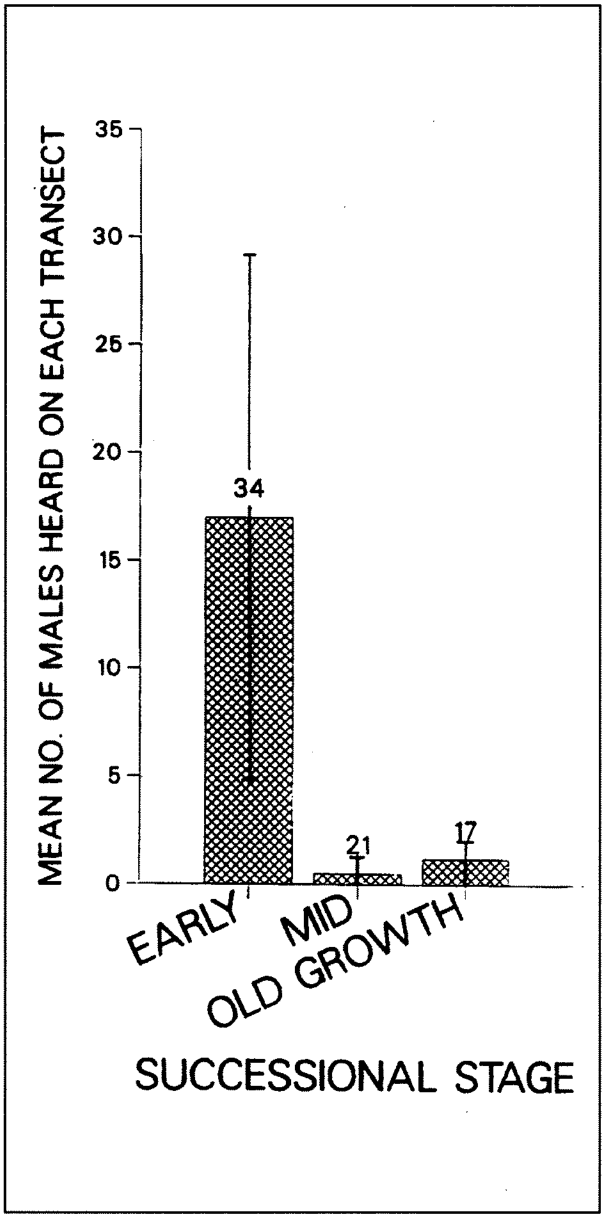

Figure 2. Audio counts of hooting males in early, midsuccessional, and old growth habitat on Hardwicke Island.

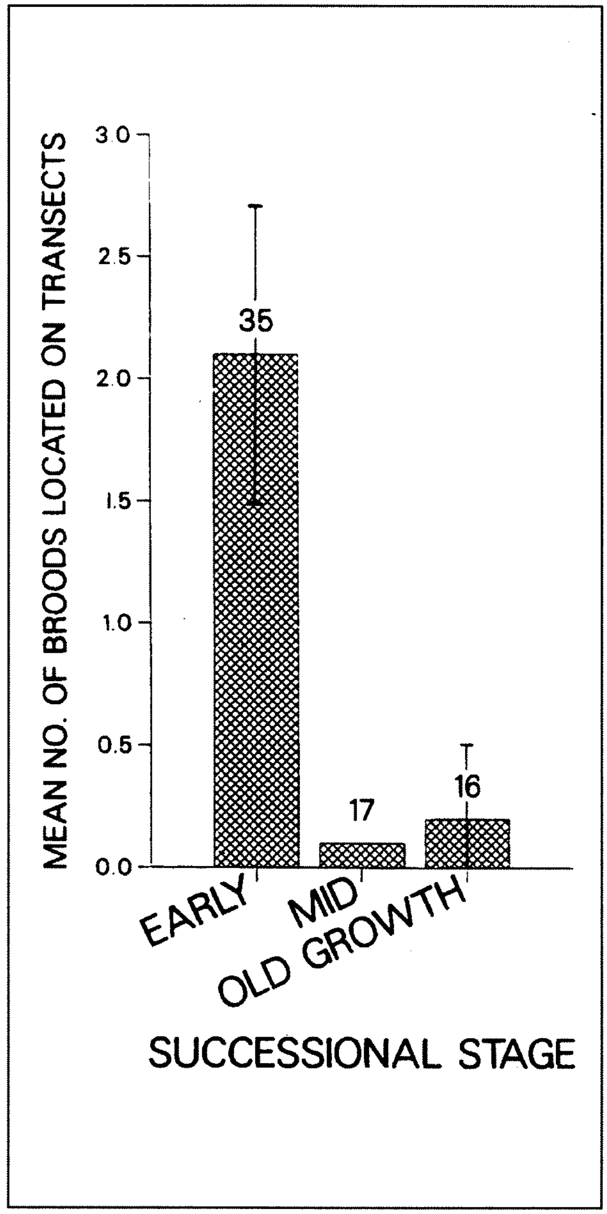

Figure 3. Counts of broods in early, midsuccessional, and old growth habitat on Hardwicke Island .

Note: Numbers within error bars denote sample size; error bars represent standard error; standard error for the mid successional habitat is zero.

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DISCUSSION

Question by Mr. Bonar: Can you tell me what those blue grouse were doing in the winter?

Response by Mr. Niederleitner: Specifically, blue grouse migrate up-slope, and they winter in larger coniferous trees. That is what the literature says. If I recall correctly, one of the people doing work on Hardwicke Island at the time did a telemetry study on blue grouse. I don't think they all moved up to higher elevations. They eat a lot of needles and spent a lot of time within the trees, so they winter within tree cover. Of course for the populations that may move up slope, the logging up slope has been a concern. Logging proceeds and has been proceeding to higher and higher elevations. For that reason, there is a concern that logging at higher elevations may affect wintering populations.

Question by Ms. Hannon: You showed that you had more broods in clear-cuts, but what about brood size? Did you look at brood size in the different successional stages?

Response by Mr. Niederleitner: The answer is no. If you recall, when you do a search with a dog, you have to control the search rates, because the dog spends a certain amount of time within each section of the transect. I was fairly religious about that. I tried to ensure that there was no more time spent than absolutely necessary between stations. I confirmed whether or not the hen was brooding, which would make you believe that there are chicks around. I usually did see chicks, but occasionally, I didn't.

Question by Mr. (Chris) Smith: You talked about canopy closure being a function of why they are utilizing forests more. Does ground cover or logs on the ground have any bearing? Do they utilize logs at all?

Response by Mr. Niederleitner: Hooting is often done on stumps and so on, but I don't think it is absolutely necessary. One of the slides that I brought illustrates a bird that was in fact hooting on a rock. That is one of my thoughts. I did have some experience with excessive slash within the clear-cut areas. On one of the transects I surveyed, in one of the clear-cut areas, there was so much slash that there essentially wasn't any ground cover. I am not sure what the relationship was. There was an incredibly high coverage of slash (something like

70 percent for all the vegetation analysis I did), which would have been an average over 15 vegetation plots. I can give you the specifics, if you are interested in knowing what the size of the plots were. The slash, I guess, can be a problem.

Comment by Mr. (Chris) Smith: If they were utilizing the sites, there was an awful lot of slack obviously in the clear-cut situation and in the old-forest. I thought there might be a relationship there.

Response by Mr. Niederleitner: I think there is some literature on slash and how it relates to grouse use.

Question by Mr. Pepper: What were the chicks eating? Were they not mostly insectivores?

Response by Mr. Niederleitner: From what I have read, the chicks are insectivores. I remember doing a number of necropsies on chicks. They do start incorporating quite a bit of green vegetable matter and even some fruits and so on. I remember seeing strawberries and the like in the necropsies, but I don't have data on that. I can just tell you what I recall. During very early stages of life, blue grouse chicks are apparently insectivores. Sue Hannon has also done work on gallinaceous birds. You may want to talk to her about that as well.

Comment by Mr. Pepper: The reason I was asking is it would seem to me there would be a species of insect that there were more of, in the cutover areas.

Response by Mr. Niederleitner: Indeed that makes sense to me. There is a whole sequence of insect succession in slash on cutovers that goes on as the insects begin to break down in slash. Obviously as clear-cuts get older, the young birds must find a fairly substantial source of insects on cutovers. That is what I would speculate.

Question by Mr. Savard: Could you speak a bit about the potential effect of herbicides on clear-cuts on blue grouse?

Response by Mr. Niederleitner: I have heard that if it is effective and it cuts off the herbaceous stratum that it could potentially have an effect. One thing to remember is that complete dense solid herbaceous development is probably not good for grouse either, because it impedes their movement. I have literature about that, and it does make sense. The ideal situation is an interspersed situation where you have the development of this shrubby layer interspersed with openings where the chicks can move around. I recalled seeing that kind of a situation on these cut blocks as well, so it is a question of degree. How much herbicide is to be used, and how significant disturbance of the herbaceous layer is going to be, are things to be considered.

Question by Mr. Savard: One last question. I remember reading that in Alaska, they got higher numbers of grouse in old-growth forest as opposed to clear-cut areas. Is that so?

Response by Mr. Niederleitner: I am aware of that literature, too. What has been documented is that occasionally grouse numbers are not high on clear-cuts. In fact in Alaska, further up towards the panhandle somewhere, you can get situations where the grouse are more abundant in old-growth forests than they are in the clear-cut areas. I think there is another observation you might want to take into consideration. It is in a paper that Fred Zwickel wrote for the Forest and Wildlife Conference sometime ago (Zwickel and Bendell 1985 - editor's note). As altitude increases, you don't necessarily get these dramatic increases in the number of blue grouse. He speculated that it might have something to do with delayed breeding at higher altitudes (i.e.,colder conditions, perhaps persisting snow, which is potentially what you might get as you go north to Alaska). You may get a situation where climatic extremes impinge upon the vegetation relationship that I was talking about.

OLD GROWTH AND OWLS: WHAT HAVE WE LEARNED?

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ABSTRACT

The current state of the knowledge of owl species that require old-growth and mature forests is reviewed. Two species are considered: the spotted owl (*Strix occidentalis*) and the barred owl (*Strix varia*). The spotted owl has been reasonably well-studied as a result of its role in the old-growth management conflict of the Pacific Northwest. Studies have shown that spotted owls select old-growth over other ages of forest and that they occur in higher densities in old-growth. The preferred prey of these owls is also more abundant in old-growth forest. The median home range size of a spotted owl pair was determined to be about 4 000 acres including a median of about 1 800 acres old-growth. Extensive modelling has shown that population stability was achieved when spotted owls were conserved in clusters of about 20 pairs. The United States Forestry Service recently adopted this approach. The barred owl is much less well-known. Studies in the United States have shown that they select mature forests, and that they require a median home range size of about 600 acres. It is strongly urged that the barred owl be evaluated as a biological indicator of mature/overmature forests in Canada for the following reasons: 1) It occurs in a range of forest types across Canada; 2) It is at the top of forest food chains and therefore requires a relatively large area in which to exist; 3) It is a year-round resident of the forest; 4) It requires cavities in large trees or snags for nesting; and 5) It is easy to detect and census because it is highly vocal. While many problems exist with the biological indicator concept, it is believed that the barred owl could be useful in determining minimum area requirements of old-growth biological communities.

This paper will start by discussing forest birds in general and the state of knowledge about them. Knowledge is reflected by the number of publications on Canadian forest birds (Table 1). The first column compares the proportion of species within each Order that occur in the Canadian avifauna with the proportion of papers that were published on that Order over the last 20 years using a simple chi-squared test. This assumes that papers should be more or less published in direct proportion to the number of species that exist in each Order in the Canadian avifauna. Only one of the eight Orders is represented more than expected in relation to the number of species that are present within it (Table 1). There were significantly fewer papers than expected or there was no significant relationship at all in the other seven Orders. In the second column, the proportion of papers within these Orders is compared annually in the literature over this 20-year period using a Spearman rank correlation. There is a significant increase in only one of the Orders (Table 1). The third column (Table 1) shows which species migrate to the neotropics, where there are current conservation problems. There are six Orders that migrate to the neotropics and only two Orders for which there are no birds that winter in the neotropics. Finally, these Orders were examined for species listed by the Committee on the Status for Endangered Wildlife in Canada (COSEWIC). A number of them are listed as endangered, threatened, or vulnerable in this country (Table 1). Taken as a whole, we do not know very much about Canadian forest birds and what we do know is not increasing.

Table 1. Knowledge of Canadian forest birds as reflected by number of publications

Order	Chi-squared output[a]	Spearman rank correlation trend[b]	Neotropical migrant	Committee on the Status for Endangered Wildlife in Canada
FALCONIFORMES (Hawks)	HIGH[c]	NS[d]	YES	YES
STRIGIFORMES (Owls)	NS	NS	NO	YES
PICIFORMES (Woodpeckers)	LOW[e]	NS	YES	NO
PASSERIFORMES (Songbirds)	LOW	DOWN[f]	YES	YES
GALLIFORMES (Grouse)	NS	NS	NO	YES
CUCULIFORMES (Cuckoos)	LOW	NS	YES	NO
CAPRIMULGIFORMES (Nightjars)	LOW	NS	YES	NO
APODIFORMES (Swifts)	LOW	NS	YES	NO

[a] Tests the proportion of species within each Order with the proportion of papers published on that Order over the last 20 years.
[b] Tests the proportion of papers within Orders represented annually in the literature over the last 20 years
[c] Significantly higher than expected
[d] Not significant
[e] Significantly lower than expected
[f] Significantly decreased

This paper is about northern forest owls and owls in relation to older forest types. A few the problem was identified. Approximately seven million acres remain of the old-growth forest in the Pacific Northwest (Thomas *et al.* 1990)

Prior to 1990, the habitat of the spotted owl was being lost at a rate of about two percent per year. There are about 20 known pairs in trends are noticed when owls are arranged in decreasing order of female body mass and the following questions were asked: where they nest; what kind of nest structure do they use, and what kind of habitat do they prefer. It would appear that most owls prefer to nest in cavities (Table 2), but there is an upper limit in the ability to nest in cavities as body size increases. Presumably this is imposed by the physical constraint of the maximum size of trees, so above a certain body size owls nest in stick nests made by other species.

Assuming that being larger means needing a larger cavity, and assuming that larger cavities are found in larger trees or larger snags, then the prediction should be that the largest of cavity nesting owls are going to be found in mature forests. That is in fact the case. The two species that stand out are the barred owl and the spotted owl (Table 2). This paper will concentrate on these two species. Quite a bit more is known about the spotted owl than we do about the barred owl because of the controversy in the Pacific Northwest. Because it does exist in mature forests, it comes into direct conflict with forest management practices. The range of the

Table 2. Nest type and habitat of northern forest owls

Species	Body mass (g)	Nest type	Forest type
Great horned	1,597	Stick	Various
Great gray	1,391	Stick	Various
Barred	506	Cavity	Mature
Spotted	502	Cavity	Mature (B.C.)
Long-eared	282	Stick	Open
Hawk	252	Cavity	Open
Boreal	224	Cavity	Open
Western screech	208	Cavity	Open (B.C.)
Saw-whet	107	Cavity	Open
Pygmy	45	Cavity	Open (B.C.)

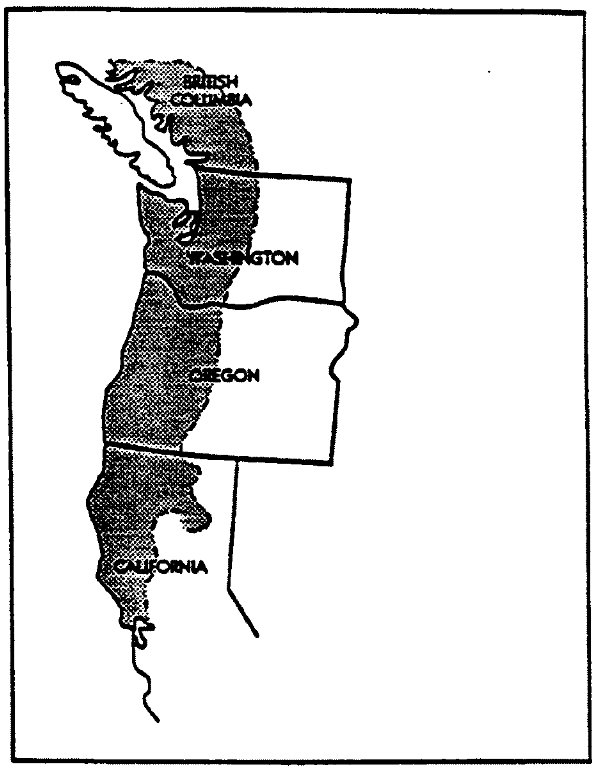

Figure 1. Spotted owl range (Thomas *et al.* 1990).

spotted owl is shown in Figure 1. Sixty percent of its habitat had already been removed before B.C., but most of the birds are found in the United States, where there are about 2 000 known pairs. There are probably as many as 3 000 pairs but of the 2 000 known pairs, 1 800 exist on federal lands with 1 400 on Forest Service lands and 400 on Bureau of Land Management (BLM) lands (Thomas *et al.* 1990).

Various researchers have put radio-tracking devices on 115 spotted owls to determine what kinds of habitats they use, and whether they are using older stands of trees more than expected on the basis of stand availability (Thomas *et al.* 1990). There is a very strong preference for old-growth use among spotted owls when comparing old-growth, mature and young stands. There is a significant avoidance of young stands, and only 16 of 115 owls preferred mature stands (Table 3). The nest sites under the heading Nests (Table 3) show a very strong preference for old-growth due to greater abundance of suitable snags and cavities in living trees. There is very strong habitat selection for old-growth.

The densities of spotted owls are higher as the age of stands increases (Thomas *et al.* 1990). They are nine times more common in habitats

Table 3. Habitat selection of spotted owls

Forest habitat	Significant + [a]	Not significant	Significant - [b]	Nests
Oldgrowth	97/115	18/115	0/115	91/97
Mature	16/115	75/115	24/115	2/97
Young	4/115	53/115	58/115	4/97

[a] + Means used more than expected

[b] + Means used less than expected

of 200 years and older and also about nine times more common in areas of high old-growth composition (Table 4).

The prey of spotted owls consists mainly of flying squirrels, and wood rats as well as some other things (Thomas *et al.* 1990). Old-growth stands tend to offer the best habitat (Table 5). There are high densities of preferred prey species which may help explain why they prefer old-growth stands.

Radio-tracking studies have shown that spotted owls need huge areas of old-growth in which to successfully raise chicks (Thomas *et al* 1990). Based on the 92 pairs that have been radio-tracked to date, the median home range size is over 4 000 acres, with some pairs even going up to 30 000 acres. Going from south to north, the home ranges increase probably because of a reduced abundance of prey (Table 5). They do have very large home ranges, but within those home ranges, they also need very large areas of old growth. Radio-tracking of 83 pairs indicates a median requirement of about 1 800 acres of old-growth (Table 6). You can easily see why there is a major controversy in the Pacific Northwest.

The effects of fragmentation on spotted owls have not been examined in any great detail. Studies on pairs with more fragmentation within their home ranges show their home ranges tend to increase. Increasing fragmentation apparently causes the owls to occupy much larger home ranges.

Until 1990, management called for spotted owl Habitat Areas (SOHAs), single-owl sites surrounded by various amounts of old-growth stands (Thomas *et al.* 1990). The Forest Service decided to set up 376 SOHAs. Each one was to be surrounded by about 1 000 to 3 000 acres, which was about 48 percent of the remaining habitat on Forest Service lands. In California, the Forest Service set up 278 SOHAs that averaged 1 000 acres. They built in a minimum of 650 acres replacement habitat that will become old-growth. Together these accounted for about 66 percent of the remaining habitat in California on Forest Service land. The BLM set aside 121 Agreement Areas of about 2 100 acres each in Oregon. That was about 28 percent of the known pairs that were on BLM land at that time.

The total number of owls that were proposed to be protected was about 780 pairs out of the estimated 2 000 pair total. Questions that arose were: Are single sites adequate? Are they going to be able to sustain the population? The two alternatives that were modelled were single sites and multiple sites. The result was to

Table 4. Relative abundance of spotted owls relative to forest age and composition

Forest age (yrs.)	Spotted owl density (owls/mile)	Oldgrowth composition of forests (%)	Spotted owl density (owls/mile)
20 - 35	0	0 - 5	0.006
36 - 45	0.08	6 - 32	0.013
46 - 60	0.09	33 - 65	0.026
61 - 80	0	66 - 95	0.045
200+	0.93	96+	0.052

Table 5. Densities of spotted owl prey

	Forest type		
Prey species	Oldgrowth	Mature	Young
Fly.squ.	High	High	Low
Woodrat	High	Medium	High
Tree vole	High	Medium	High

Table 6. Area of home ranges of spotted owls

Home range characteristics	Number of pairs	Median area (acres)	Minimum area (acres)	Maximum area (acres)
Total area	92	4 089	1 035	30 961
Area of oldgrowth within home range	83	1 796	367	20 561

endorse the multiple-site route based on applied and theoretical island biogeography and from demographic studies of spotted owls. Population models of single and multiple-site habitat alternatives were run, and in all cases the populations became extinct in the single site habitat. Population stability was finally achieved in the modelling with clustered groups of about 20 pairs of spotted owls (Figure 2).

One of the most critical variables in the modelling exercises turned out to be the dispersal of the young birds from the nest. They must disperse into suitable habitat in order to replace adults that are dying. Radio-tracking young birds as they left their nests indicated that some of them go up to 50 miles away, but most within around 25 miles (Figure 3). It was recommended in 1990 that there should be multiple sites of a minimum of 20 pairs apiece, rather than having single sites. In 1990, the SOHA concept was replaced by the Habitat Conservation Area (HCA), which called for a minimum of 20 pairs which, when modelled, gave a stable population.

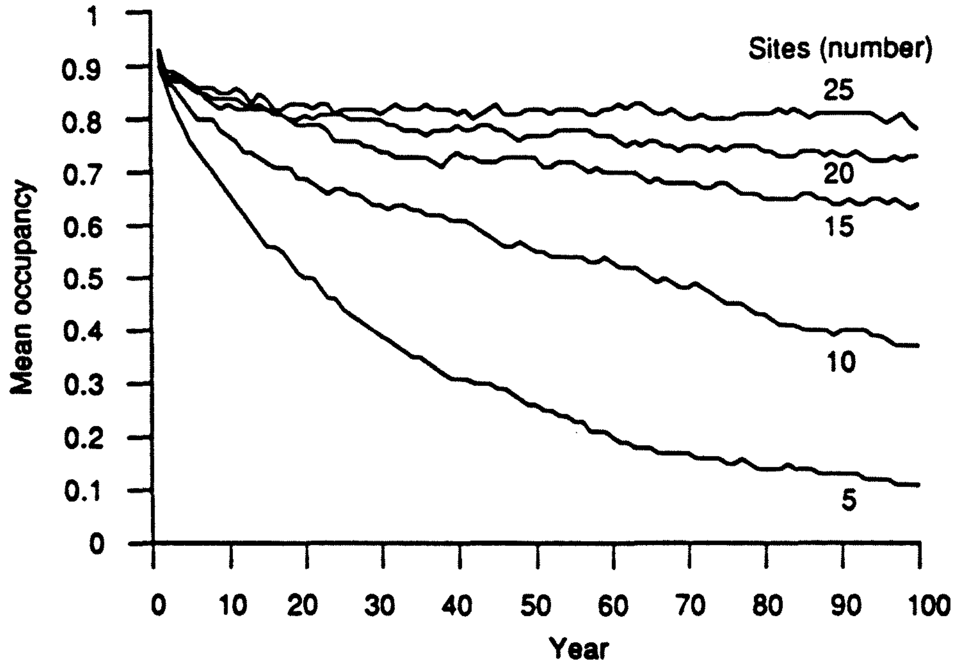

Figure 2. Example of model showing stability at clusters of about 20 pairs (Thomas *et al.* 1990).

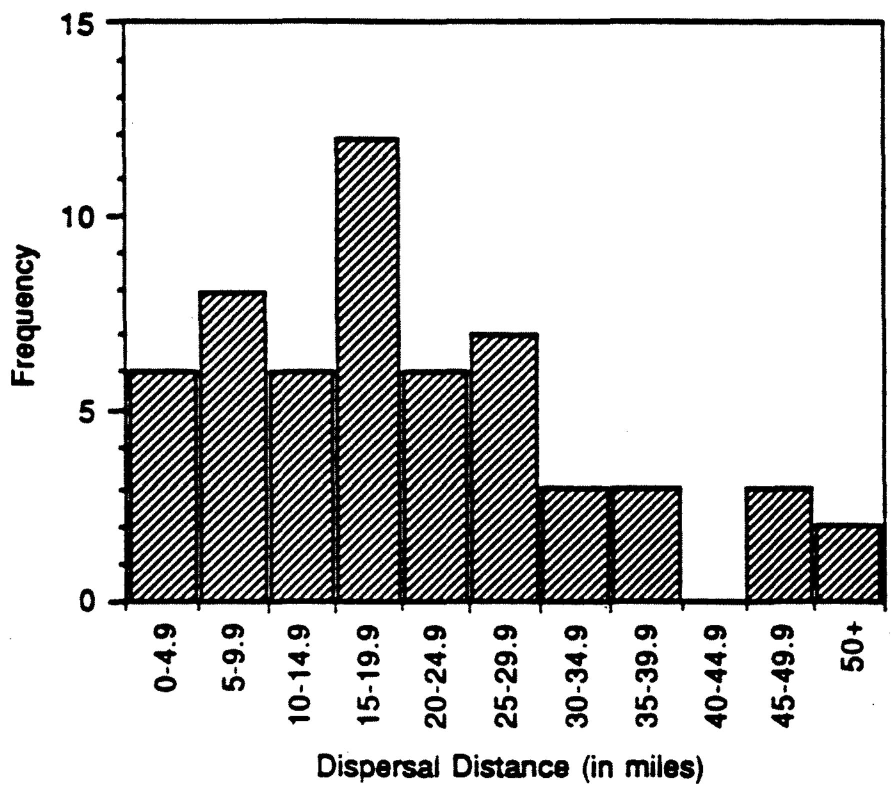

Figure 3. Spotted owl juvenile dispersal (Thomas *et al.* 1990).

Each HCA size was calculated by multiplying 20, (which was the number of pairs), by the median home range of that particular region by 0.75 (to account for overlap between neighbouring pairs). The home ranges tended to change with latitude and also with physiographic features. The distance between HCAs was set at 12 miles from edge to edge. That was estimated to capture about two-thirds of the dispersing juveniles. The modellers felt that in a suitable habitat, the owls' needs would be taken care of (Thomas *et al.* 1990).

The rationale behind the current conservation strategy is basically that large plots are better than small ones, and continuous habitat is better than fragmented habitat. The habitat between the blocks should be suitable for dispersal. Plots should be closer together rather than further apart. The habitat blocks should be grouped equal distances from each other rather than be strung out in a line. The habitat block should be as circular as possible to minimize internal dispersal distances (Thomas *et al.* 1990).

The conservation strategy initially is conservative and controversial. It has resulted from two things: 1) the known impact of clear-cutting on spotted owls; 2) the flip side is not knowing how to safely schedule timber harvests in and around spotted owls. The plan therefore called for an responsive process whereby the needs for spotted owls and forestry could be worked out in a compatible way. This used the concept of adaptive management.

Adaptive management means undertaking research as part of the management instead of researching a problem and then changing the management. The timber harvest is scheduled in such a way to create the habitats that are wanted. Experiments are conducted and the results are found out, while management is going on. This is a very important approach that we need to take in Canada. The barred owl is the other species of large cavity nesting owl. It occurs across Canada (Figure 4) in a number of forest types.

In Saskatchewan, barred owls are strongly associated with mature stands of large white spruce distributed through the mixedwood belt[1]. Unfortunately, these stands of trees tend to be in short supply and are also much sought after by forest products companies. No systematic studies have been conducted in Canada.

In Minnesota, radio-tagged barred owls have shown that they prefer mature stands of trees and avoid younger stands of trees (Table 7). Also, in New Jersey, the barred owls tend to occur more often in older stands (Figure 5).

Home range has been determined only for a couple of places. The home range is about 500 acres for barred owls in Minnesota (Nicholls *et al.* 1972). The same research in Canada would find that home ranges in Saskatchewan are probably in the order of 1 000 acres because of the home range/latitude relationship already

First of all, it does occur across Canada in various forest types. It is at the top of food chains, therefore it requires a relatively large area in which to exist. The confounding problem of a neotropical migrant that suddenly declines in numbers does not exist because it is a year-round resident. Is it declining in numbers because of habitat loss in the south or because of habitat loss in the north? The barred owl requires cavities in large trees or snags for nesting. It is one of the few owls that can be heard calling in the daytime as well as at night. Therefore, it is easy to detect and easy to census. It could be a very useful indicator for these reasons.

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[1]Unpublished report. Smith,A.R. The atlas of Saskatchewan birds. SNHS special publ. (In press).

Figure 4. Barred owl range in Canada (Godfrey 1986).

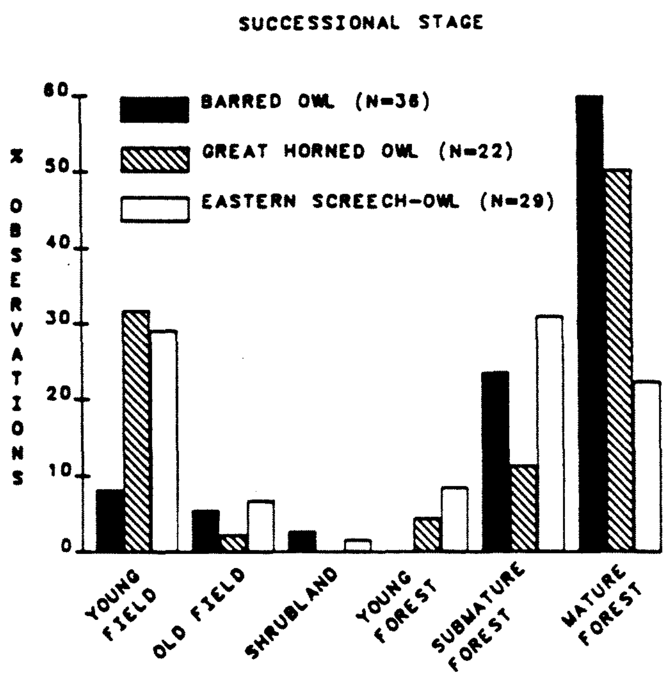

Figure 5. Barred owl habitat use in New Jersey (Bosakowski *et al.* 1987).

Table 7. Habitat selection by barred owls in Minnesota (Nicholls *et al.* 1972)

Habitat	Significant + [a]	Not significant	Significant - [b]
Oak woods	9/9	0/9	0/9
Mixedwoods	2/3	1/3	0/3
Oak savanna	1/6	0/6	5/6
Alder/cedar swamp	0/16	1/16	15/16
Field/marsh	0/18	1/18	17/18

[a]Used significantly more than expected.
[b]Used significantly less than expected.

There have been papers about indicators and their limitations at this workshop. The main problem with indicators is that it is very difficult to separate out the many factors that can cause changes in bird populations, especially if the bird is migratory. As an example, the pileated woodpecker has been adopted as a mature forest indicator by the Forest Service and the Saskatchewan Forest Habitat Management Project. Researchers followed a number of radio-tagged woodpeckers and found that the birds spent approximately 20 percent of their time foraging in younger stands (Mellen 1992). What other species are the woodpeckers indicating? They illustrate that the way indicators are chosen must be done very carefully. However, don't throw out the baby with the bath water. Selections of potentially good indicators showing good statistical relationships could be very useful.

The prospect of ornithologists and foresters working together is exciting. A lot can be learned from each other and it should be started as soon as possible.

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DISCUSSION

Comment by Mr. Erskine: There is one study of barred owls in Canada, a master's thesis from Acadia University in Nova Scotia completed in 1987. Perhaps the significant thing about that was the study was conducted largely on barred owls using nest boxes, which is a point that has not been brought out in the biology of barred owls elsewhere. They quite readily took to nest boxes in that area.

Response by Mr. James: Yes, I am aware that barred owls will use boxes if they are provided. Has that study from Acadia been published?

Response by Mr. Erskine: I don't know.

Comment by Mr. Savard: I have one question. Was there any relationship between the dispersal distance of the young spotted owl and the fragmentation around the nest?

Response by Mr. James: I don't know. I would suspect that dispersal distances would increase with increasing fragmentation.

Question by Mr. Lakusta: You suggested that the barred owl could be used as a Canadian example to indicate old-growth, somewhat like the spotted owl has been used for the rain forest old-growth. Don't you think that is a bad example to follow? Do you have any comment?

Response by Mr. James: My reason for talking about barred owls is I think we can avoid the conflict that exists in the Pacific Northwest, and I think that is exactly the reason for looking at barred owls. The old-growth issue rushed up on the Americans quickly, and became a political agenda instead of a scientific agenda. That it is a very sad situation, and I think we can avoid it here. I think we have the breathing space to avoid that situation. Whether we like it or not, barred owls appear to require mature forests, and I don't think we can ignore that.

FOREST BIRD RESPONSE TO NATURAL PERTURBATIONS AND SILVICULTURAL PRACTICES : DOES LOGGING MIMIC NATURE?

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and

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ABSTRACT

The rich literature on forest birds is used to assess and compare the ecological consequences of various types of forest disturbance. Forest exploitation, like natural perturbations, has the effect of restoring forest succession. Although, there are striking resemblances between the landscape that results from the two forms of disturbances, there are differences between natural perturbations and those that are caused by current forest practices. Above all, natural perturbations favor horizontal heterogeneity of stands, whereas logging, since it is not planned at various scales (both in space and time), has a tendency to simplify the habitat mosaic over vast areas.

A management strategy designed to mimic natural processes as closely as possible should favor the establishment of a complex mix of plant strata within stands and a varied mosaic of habitats forest-wide. This increased partitioning of the forest landscape favors bird species' richness and plays an important role for the maintenance of regional biodiversity.

MYTH OR PARADIGM

There is a widespread belief that forestry operations do no more than mimic the normal regenerative processes of the boreal forest, so that their impact is the same (Hall and Thomas 1979; Titterington *et al.* 1979). This belief seems to have no solid scientific basis. It is a paradigm which has gradually taken hold on the basis of the striking resemblance between landscapes subjected to both kind of disturbances. Fires and insect epidemics do indeed, like logging and planting, substantially alter the composition and structure of stands. Most often, these disturbances have the effect of promoting growth of shade-intolerant deciduous species, thus re-establishing forest succession. Looking at individual stands, silviculture may appear to be "naturally" good for the forest, but what is the picture at the level of biocenosis and regional biodiversity?

There is a rich literature on the importance of the composition of the flora (Franzreb 1978; Holmes and Robinson 1981; Rotenberry 1985; Ménard *et al.* 1982) and of the plant structure of habitats for forest birds (MacArthur and MacArthur 1961; MacArthur *et al.* 1966; Haapanen 1965; Hooper and Crawford 1969; Willson 1974; Evans 1978; Anderson 1979; Probst 1979; DesGranges 1980; James and Warner 1982). These sources will be used to assess and compare the ecological consequences of various types of forest disturbance. On the strength of this analysis, we will be able to verify the truth of the initial paradigm and evaluate (DesGranges and Rondeau 1993) the various options for forestry management in a context of sustainable development, and maintenance of biodiversity. Interested readers will find in Rondeau and DesGranges (1993a) a detailed list of recommended forestry practices for making the best overall use of natural forest ecosystem components while providing for continued harvesting of timber.

HABITAT DIMENSIONS

The composition and abundance of bird life in the forest depend on a number of factors (Cody 1974; Capen 1979; Sanderson *et al.* 1980; Smith 1980). These factors can be represented as the dimensions of a hypervolume in which species are distributed among the various compartments or niches (Hutchinson 1957). The more compartments there are, the greater the number of species that can occupy the same area. These habitat dimensions are precisely where disturbance of the forest is felt. In the majority of cases, trees are seriously affected, which leads to a change in the number, size and composition of forest strata, or **vertical heterogeneity** (Hunter 1990).

Depending on the scale and spatial pattern of the disturbance, the area will become a mosaic of more or less complex, varied habitats, corresponding to **horizontal heterogeneity** (Hunter 1990). Geometric pattern, from regular to highly reticulate, is of great significance for this habitat axis. The more pronounced the intermingling of habitats, the more ecotonal bands and habitat types there are.

Another important factor in the forest landscape derives from the age of stands. Depending on whether they favour variable-age stands (uneven as opposed to even-aged) or adequately recreate the mosaic of successional seres (pioneer stands to climactic stands, with transitional stages in between), disturbances will have variable effects on the richness of bird life.

Complexity of the forest mosaic, though of prime importance, is not the only criterion with a bearing on diversity of bird life. Intraspecific and interspecific competition also plays a significant role in cases where major resources are scarce. Availability of food resources and of suitable nesting sites in sufficient quantities imposes severe constraints, especially on species which are highly specialized in these matters.

NATURAL DISTURBANCES AND FOREST SUCCESSION

Forest succession is a natural phenomenon in any forest ecosystem. The virgin boreal forest is a mosaic of stands in different stages of succession, resulting from previous disturbances caused by fire or insects. The conifer dominated forests of northern Canada generally have an even-aged structure. The dominant species regenerate *en masse* after major disturbances over large areas, such as may be left by fire. Balsam fir (*Abies balsamea*) stands usually have an uneven-aged structure because it is a shade tolerant species. Major disturbances resulting from spruce budworm (*Choristoneura fumiferana*) epidemics are common in these forests, and this favours an even-aged structure of the dominant trees (Maclean 1988). The way that many species have adapted to major fire disturbances confirms the importance of this phenomenon in these ecosystems. The jack pine (*Pinus banksiana*), black spruce (*Picea mariana*), aspen (*Populus tremuloides*) and white birch (*Betula papyrifera*) are all adapted to colonizing burned lands.

The hardwood forests of southeastern Canada generally have an uneven-aged structure. They consist of species which regenerate naturally under their own cover, or in small or medium-size natural clearings. In hardwood forests, fires are rare. Windthrows are common, but they rarely open up a large area unless they result from severe storms. Most disturbances are due to the fall of a single tree or a small group of trees,

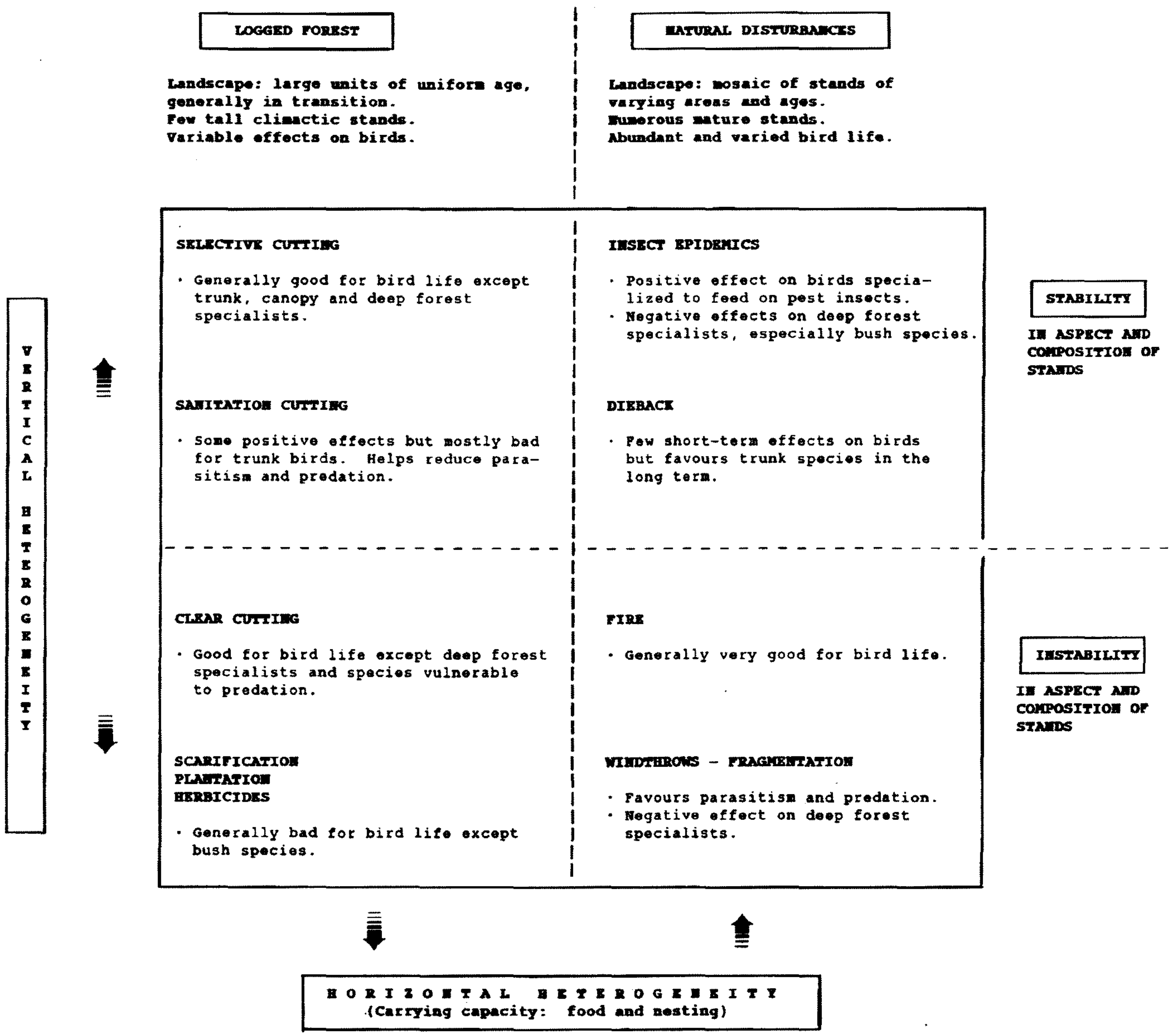

Figure 1. Model showing the effects of distrubances on the landscape and the bird life of Canadian boreal forests.

leaving an opening in the canopy. Some species with a moderate tolerance for shade flourish in such clearings [e.g.: yellow birch (*Betula alleghaniensis*), white ash (*Fraxinus americana*), red oak (*Quercus rubra*)]. The mound of soil created by the uprooting of the trunk may promote the growth of saplings, such as yellow birch.

On the eastern part of the Precambrian shield, in the intermediate zone between northern hardwood and boreal forest there is a zone of mixed forest, for example, sugar maple (*Acer saccharum*) mixed with yellow birch and fir stands (balsam fir mixed with yellow or white birch) (Rowe 1972). Here, the pattern of disturbance is complex and poorly understood. This is because of the important role of spruce budworm epidemics and clearings created by windthrows and fire (not to mention the complex interactions between these disruptive factors). On the southwestern part of the Precambrian shield, (north of the aspen parkland), is a section of mixed wood. The characteristic forest of the well-drained uplands is a mixture in varying proportions of aspen and balsam poplar (*Populus balsamifera*), white birch, white spruce (*Picea glauca*) and balsam fir; the last two species being especially prominent in old stands. The dominant cover type is the aspen, a result of the ability of this species to regenerate readily following disturbance (Rowe 1972).

DISTURBANCES AND FOREST LANDSCAPE

The boreal forest is in continual evolution. Because a full cycle in the forest succession generally takes over a century, few stands reach the relatively stable climactic phase. Even when they do, they all sooner or later meet with a natural or man-made disturbance which will set them more or less back to the start of the secondary succession. These numerous fresh starts help to maintain a diversity of habitats and are essential to maintenance of biodiversity.

Figure 1 compares different types of disturbance in terms of their consequences for the forest. They are shown in four blocks, arranged on the two orthogonal vectors that represent the resulting degree of vertical heterogeneity (bottom to top) and horizontal heterogeneity (left to right). Note a distinct separation between natural (on the right) and man-made disturbances (on the left) in terms of horizontal heterogeneity, but not in terms of vertical heterogeneity. The latter vector tends to divide the transitional (at the bottom) and climactic phases (at the top).

OPTIMUM VERTICAL AND HORIZONTAL HETEROGENEITY

The forest is most compartmentalized when both vertical and horizontal heterogeneity are favoured. This occurs usually in the aftermath of an **insect epidemic**, when many trees have been weakened to the point of dying (Rondeau and DesGranges 1993b).

In coniferous forests, it has been found that in the short term, trees infested with phytophagous insects provide ample food supplies. This reduces intensity of intraspecific and interspecific competition, attracting many insectivorous birds, both specialized and generalized feeders (Morris *et al.* 1958; Crawford *et al.* 1983). Over the medium term, the dying trees are attacked by wood-eating insects, thus providing a food source for woodpeckers (Van Tyne 1926). Eventually, rot sets in, facilitating the excavation of cavities by primary cavity nesters (Bull *et al.* 1980). Finally, as a result of windthrows, the defoliated coniferous forest acquires a mixed character. This attracts species that customarily inhabit the crowns of deciduous trees in pockets of regenerating mixed woodland within coniferous forests (Crawford *et al.* 1983; Rondeau and DesGranges 1993b) or which live in the brush on the forest floor growing where an epidemic has left gaps among the dense stands of mature fir (Rondeau and DesGranges 1993b).

The severity and scale of damage varies, depending on the geographical situation, age and composition of the stands, affecting the type of mosaic created (Thompson 1993). Insecticide spraying may affect development of the mosaic by allowing some old stands to survive in spite of the insect infestation. If they are not toxic to birds, if their action is limited to the targeted insects and if they are used intermittently, insecticides may not cause serious harm to insectivorous birds. Most species can temporarily forage lower in the canopy and in a greater variety of trees to take in insects not affected by the spraying (Hunter and Witham 1985). Species dependent on insect pests for food can always move to available unprotected stands which are essential to the forest.

Forest dieback is a complex phenomenon resulting from both natural (climatic stress), and man-made (atmospheric pollution) factors (Dessureault 1985). It should have medium-term effects on landscape comparable to those of insect epidemics. In both cases, there is a progressive defoliation of the tree stratum, but unlike infestation, dieback does not seem to be accompanied by epidemic proliferation of phytophagous insects. Such is the case for the current dieback among Quebec maples. This explains why insectivorous birds have shown little reaction to changes in canopy foliage (average loss 30%) due to the dieback of Quebec maples (Darveau *et al.* 1990, 1992). The presence of numerous dead or dying trees, with bark shredding and peeling, may promote the proliferation of wood-boring insects and of the birds that feed on them. As rot sets in, woodpeckers should be able to excavate more nests, attracting other species that nest or roost in these cavities. The dead trees will fall, creating openings for the establishment of young hardwoods and a ground cover suitable for species not usually found in dense forest (DesGranges 1987; DesGranges *et al.* 1987).

DECREASED VERTICAL AND OPTIMUM HORIZONTAL HETEROGENEITY

Natural fires are common in the boreal forest, and most of them are destructive (ie; crown fires) and relatively extensive. In northern hardwood forests, they are quite rare, and their localized effects are usually felt only in the forest understory (Spurr and Barnes 1980). Fire plays a major role in recycling the minerals stored in the biomass. When released and returned to the soil by combustion, these mineral elements can be used for plant growth and guarantee the productivity of the site. In logged forests where a substantial portion of the biomass is removed (Spurr and Barnes 1980), this does not happen.

By reducing the number of forest strata, fire diminishes vertical heterogeneity. By creating openings of various sizes in the canopy, however, it breaks the monotony of the landscape and re-establishes the succession, with a concomitant positive effect on horizontal heterogeneity. It may have a positive impact on standing crop biomass and diversity of bird life by creating ecotones (Bock and Lynch 1970) and by recycling nutrients (Thomas *et al.* 1975).

Even more than fire, extensive **windthrow** and **forest fragmentation** (e.g., land cleared by the early colonists and patchwork logging or clearance for regeneration) induce highly localized alterations to the composition of the forest. Surface fires may destroy the understory to a greater extent than the main forest canopy, whereas windthrow damage is chiefly confined to the overstory (Spurr and Barnes 1980). Creating pockets of regenerating forest and multiplying the number of ecotonal bands (rich in seeds and fruits), help maintain species adapted to transitional habitats. Taken together with species typical of climactic forest, they enhance regional biodiversity accordingly (Haila *et al.* 1980; Hanson 1983; Helle 1983; Freemark and Merriam 1986). Hawking flycatchers, and ground feeding seed eaters might be particularly attracted by openings in the forest canopy (Haapanen 1965; Kilgore 1971; Franzreb and Ohmart 1978; Beedy

1981). The density of many forest species may even be greater near regenerating pockets (< 50 m) (Haila *et al.* 1980; Hansson 1983; Helle 1983). Hansson (1983) attributes this phenomenon to a greater abundance of insects on trees newly exposed to frost, sun, and wind damage where the canopy has been opened by disturbances. Yet, these climatic stresses might also be responsible for a lower breeding success for those birds who choose to nest in these kinds of "ecological traps".

As long as openings are small (< 8 ha) (Crawford and Titterington 1979), and represent only a small proportion of the forest area, species adapted to mature forest do not seem to suffer much (Yahner 1986; Derleth *et al.* 1989). Too many clearings in a dense forest may increase the risk of nest predation by corvids (Yahner and Scott 1988) and attract into the forest such nest parasite species as the brown-headed cowbird (*Molothrus ater*) (Gates and Gysel 1978; Robbins 1979). Many mature-forest species make open nests easily found by cowbirds, and generally raise only one brood per year. Some writers suspect that this phenomenon may have serious consequences for the annual production, and maintenance of certain forest bird populations (Robbins 1979). Whatever the case, it is important to maintain large enough parcels of habitat linked by natural corridors or located close enough together to allow species with extensive territory needs to become established (Probst 1979). As forests become fragmented under the pressure of development, a region's bird life becomes impoverished (Whitcomb *et al.* 1977). Mature forest becomes limited to scattered islands within a landscape artificialized by agriculture, urban development or logging (Whitcomb *et al.* 1981; Haila 1986; Haila *et al.* 1987; Virkkala 1987). Although habitat may be adequate, the small size of wooded areas increasingly (if not entirely) discourages many species adapted to the deep forest (Moore and Hooper 1975; Gavareski 1976; Tilghman 1977; Freemark and Merriam 1986; Askins *et al.* 1987). This is the case of many neotropical migrants whose populations in the northeastern part of the continent are now in decline (Robbins 1979; Whitcomb *et al.* 1981).

Optimum vertical heterogeneity and decreased horizontal heterogeneity

Thinning (before an even-aged stand has reached harvesting age) and single-tree **selective cutting** (in uneven-aged stands) are two types of periodic partial harvesting used to improve the growth and quality of stands. They have a positive effect on vertical heterogeneity. In fact, these cutting practices have the advantage of maintaining good stratification of the plant biomass and a diversified age structure. As the trees taken are often understory species or those without economic value, such manipulation usually creates few regenerating pockets in the forest canopy. By hindering establishment of a more complex forest mosaic, it does little to promote horizontal heterogeneity. Studies of the effects of selective cutting on bird life have produced contradictory results. Some have concluded that by favouring layering and development of the plant biomass, these forestry practices enable greater numbers of birds to move into the managed stands (Hooper 1967; Frank and Bjorkborn 1973; Webb *et al.* 1977; Crawford and Titterington 1979). Others have failed to detect any significant effects on bird life (Michael and Thornburgh 1971) or have, in contrast, noted a decline in the abundance of birds in stands subjected to selective cutting (Franzreb and Ohmart 1978).

Improvement (sanitation) cutting is carried out on stands with an irregular structure to eliminate defective trees, and leave a healthy and productive uneven-aged stand. Although it favours vertical heterogeneity and a varied age structure (like other forms of selective cutting), it negatively affects many birds. By taking out sick, dead or deformed trees, it reduces the number of perches available to raptors and flycatchers (Miller and Miller 1980; Scott *et al.* 1980). Also affected are the quantity of food available to drilling and trunk-creeping species (Conner *et al.* 1975; Maser *et al.* 1979; Thomas *et al.* 1979). The availability of nesting sites for those species that nest in cavities excavated in stumps (Haapanen 1965; Balda 1975; Evans and Conner 1979; Mannan 1980; Brush 1981; Raphael and White 1984; Zarnowitz and Manuwal 1985; Land *et al.* 1989) or in fallen trees lying on the forest floor in an advanced state of decay (Miller and Miller 1980) is reduced. As most cavity-nesting species are permanent residents and use them year-round for roosting, the importance of these large dead trees for the stability of these bird populations can well be imagined (Short 1979).

Decreased vertical and horizontal heterogeneity

Although large-scale **clear-cutting** (clear-cutting > 40 ha, e.g., Austin and Perry 1979) takes in areas in the range of those cleared by fire (Hagar 1960; Seiskari 1962; Back and Lynch 1970; Webb *et al.* 1977; Taylor and Barmore 1980; Helle 1985), the frequency distribution of fire sizes and cutblock sizes in the boreal forest differs markedly. Logging does not usually result in the creation of as complex a habitat mosaic (ie: horizontal heterogeneity) as does fire. The latter leaves live residual stands, burned trees, and fallen woody debris while with the former, most stems are removed from the site (Telfer 1993; Thompson 1993). Unlike fire, clear-cutting does not release the nutrients stored in the biomass and organic litter by incineration. Instead it removes them, unless lopping is done at the cut site. Felling cycles for any given site are determined by economic criteria (i.e. as short as possible). These do not necessarily correspond with plant succession, thus the ecological process is undermined, leading to a decline in forest productivity (Kimmins 1987).

For these reasons and because clear-cutting is often accompanied by "aggressive" forestry practices such as scarification and suppression of competing plant species, most writers consider this form of harvesting to be the most likely to adversely affect local bird life (Hagar 1960; MacDonald 1965; Balda 1969; Wiens 1973; Franzreb 1977; Slagsvald 1977; Savidge 1978; Capen 1979; Conner *et al.* 1979; Crawford and Titterington 1979; Probst 1979; Rotenberry *et al.* 1979; Roth 1979; Titterington *et al.* 1979; Anderson and Ohmart 1980; Morrison and Meslow 1984; Rice *et al.* 1984; Biggs and Walmsley 1988; Santillo *et al.* 1989; Mackinnon *et al.* 1990). By eliminating the majority of trees and stumps over large areas, clear-cutting minimizes compartmentalization, and diminishes the number of ecological niches available. Commercially viable tree species replace the "undesirable" ones, and their monocultures are enhanced by **plantation** and/or by **herbicide spraying**. As mature stands are the industry's main focus, they are habitually harvested first for fear that they may fall victim to fires or insect epidemics. This results in the "coniferization" of large cut-over areas which lead to a reduction in bird species adapted to certain transitional phases, (e.g. shade-intolerant hardwoods) (Hardy and DesGranges 1990), and to certain species of mature forest tree (Thomas *et al.* 1979; Mannan 1980; Whitcomb *et al.* 1977). As well, there are reductions among many bird species with specific feeding requirements, (e.g. trunk-creeping birds, raptors and flycatchers) (Conner *et al.* 1975; Miller and Miller 1980; Dickson *et al.* 1983) or specific nesting needs, (e.g. cavity nesters) (Gysel 1961; Haapanen 1965; Brown and Orians 1970; Balda 1975; Thomas *et al.* 1976; Evans and Conner 1979; Short 1979; Franzblau and Collins 1980; Mannan 1980; Brush 1981; Dickson *et al.* 1983; Raphael and White 1984; Zarnowitz and Manuwal 1985).

Bird species richness may increase over time on sites that have been clear cut and attain and even exceed levels in mature stands (Hagar 1960; Hooper 1967; Resler 1972; Ambrose 1975; Yahner 1988; Thomas *et al.* 1975). This type of major disturbance helps relaunch the plant succession with its full train of pioneer and transitional species. The ecotonal bands bordering the cut-over areas (Willson 1974), and the rapid succession of habitats in areas cut in different years help to form distinct successional seres (about four for hardwood forests (May 1982) and five for coniferous forests (Titterington *et al.* 1979)), with a corresponding variety of environments for birds. The species favoured form the species cohort associated with the beginning of the forest succession (Roth 1976; May 1982; Niemi and Hanowski 1984; Weimore *et al.* 1985). When this process has run its full course, these species may occupy the whole area, whereas some species typical of mature stands, especially those that inhabit extensive old forests, will disappear under the pressure of logging operations. Such a scenario, though it favours local diversity, actually represents a net loss in terms of regional biodiversity (Wiens 1975).

CONCLUSION

Forest exploitation, like natural perturbations, has the effect of restoring forest succession. Although there are striking resemblances between the landscape that results from the two forms of disturbances, there are differences between natural perturbations, and those that are caused by current forest practices. Natural perturbations favor horizontal heterogeneity of stands, whereas logging, because it is not planned at various scales (both in space and time), has a tendency to simplify the habitat mosaic over vast areas.

A management strategy designed to mimic natural processes as closely as possible should favor the establishment of a complex mix of plant strata within stands and a varied mosaic of habitats forest-wide. This increased partitioning of the forest landscape favors bird species' richness and plays an important role for the maintenance of regional biodiversity.

ACKNOWLEDGEMENTS

A number of the ideas developed in this article came from a brainstorming session on the forest protection strategy statment recently put forward by the Quebec Forestry Department and in which one of the authors (DesGranges) participated. We are particularly indebted to Daniel Gagnon and Yves Bergeron (two forest ecologists at the Universite du Quebec à Montréal), who also participated in the study session and formulated some of the concepts enunciated in this paper. We would also like to thank Marcel Darveau and Jean-Pierre Savard (Canadian Wildlife Service, Quebec Region) and Malcolm Hunter (University of Maine) for their perspicacious comments upon reading this article.

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DISCUSSION

Question by Mr. Hunter: When you refer to deadfalls, I take it you mean that individual trees in an older forest fall down to create small canopy gaps ?

Response by Mr. DesGranges: Yes, but often it will be more than one tree. Windthrows in Quebec usually cover fairly large areas.

Question by Mr. Hunter: How large?

Response by Mr. DesGranges: It depends on wind speed. Windthrows are most often associated with severe storms and tornadoes. Large expanses of forests can be destroyed. I know of a fairly large island in the St. Lawrence estuary where most of the fir trees were blown down during a storm. I realize that deadfalls often create small gaps in the forest.

Comment by Mr. Hunter: My image of a tree falling is one, two or three trees, a fraction of a hectare, in which case I would say that that is not creating horizontal heterogeneity from the perspective of a typical bird. Clearly whether you call clear-cutting low heterogeneity or tree fall gaps high heterogeneity is dependent on the scale of the species you are talking about.

Response by Mr. DesGranges: In the literature, we found that few authors were suggesting 40 hectares. If the cutover area is less than 40 hectares, it is not harmful to birds, but if it is more than that it is not good for the regional biodiversity. It is too much clear-cutting, but it all depends on the patterns that you are making in the landscape with the logging operations.

Question by Mr. Diamond: The other aspect of clear-cutting that I think is worth talking about is not the forest that is gone; it is the forest that is going to be there in 50 to 100 years. I think when we are talking about the size of a cut, we need to think clearly about the immediate loss versus a long-term benefit. A big clear-cut much more than 40 acres may actually be better in terms of creating a forest for the future rather than focusing on the forest that you have lost now.

Response by Mr. DesGranges: It is a matter of how intensive forest management operations are in an area. Twenty years after cutting, you will find more birds than there were soon after harvest, but they will not be the same species. They will be transitional species, for which there may be plenty of habitats available. The long-term benefits from large clear-cut areas that you anticipate 50 or 100 years from now seem very uncertain to me because of the increasingly widespread practice of spraying plantations with herbicides. These practices allow the rotation period to be substantially shortened, but important stages in forest succession are skipped. We will see a gradual decline in birds that frequent shade-intolerant deciduous species, as well as those that depend on mature stands, if this trend continues. Clear-cuts will be larger and there will be a greater chance of them being closer together.

Comment by Mr. Diamond: Obviously the spatial scale and the temporal scale have to be concorded if you are going to look at it as a future forest. You have to expand and extend the rotation to allow clear-cuts to become the two forests.

Comment by Mr. Bortolotti: This is more of a comment. The biggest difference between forestry operations and natural perturbations has nothing to do with what you are talking about. The biggest difference is that there are roads associated with forestry operations. I am speaking from 16 years of experience in an area of rural Saskatchewan that spanned preharvesting and postharvesting. The biggest impact, not necessarily on all bird populations, but certainly on the land, is road building. We have not only bird researchers running around, we also have a correctional camp. We have fishing camps, tremendous recreational opportunities, a large reserve with a large population of people, poaching problems, and blueberry pickers who don't want the forest back. One of the assumptions when we are removing trees and altering the landscape is that then we are just part of this natural cycle. In fact we are currently changing some of the landscape, not necessarily in a biological way, but because we are providing access. There are more fires. It means that more roads are built. For example, in this area, there is selective logging going on. Certainly birds of prey, game birds, and waterfowl are susceptible to human disturbance, and are very much altered. That is something that is not predicted by looking at the natural history.

Response by Mr. DesGranges: I agree with you. I think we have to discuss what kind of integrated forest management we want to encourage. If we favour extensive forest exploitation, modification of forest composition and structure over large areas will be the result. If we opt for intensive forestry around mills using plantations, herbicides and insecticides to make the forest highly productive, the extent of forest harvesting would be limited. This may be a better choice because there will be more natural habitats left for birds and for wildlife and for other users of the forest. I think that this is the future of integrated forest management. We will have to make a decision. As ecologists, we may feel that using insecticides and pesticides and planting trees is unacceptable, but it may help us protect other areas which are much more important to the maintenance of natural biodiversity. There is a review of the literature available.

A RESEARCH PROJECT TO STUDY THE EFFECTS OF CLEAR-CUT HARVESTING ON BIRD DIVERSITY IN ASPEN MIXEDWOOD COMMUNITIES OF ALBERTA

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ABSTRACT

A Forest Management Agreement (FMA) has been recently negotiated between Alberta-Pacific Forest Industries (Al-Pac) and Forestry, Lands and Wildlife for an extensive area of mixedwood forest in northeastern Alberta. Much concern has arisen as the result of the large scale of this forestry operation, and its potential adverse affects on the aspen/mixedwood community. Little species-specific information is available on the FMA to address these concerns. In view of these concerns, the Alberta Environmental Centre is embarking on a five year study which will provide quantitative information on the wildlife and vegetation in aspen/mixedwoods on Al-Pac's FMA, as well as examining the effects of clear-cut logging on the biodiversity of the residual stands. A major goal of the study is to provide appropriate agencies with information which will assist in the sound management of this renewable resource.

INTRODUCTION

Alberta-Pacific Forest Industries (Al-Pac) has recently negotiated a Forest Management Agreement (FMA) with Alberta Forestry, Lands and Wildlife. The FMA covers a large area of boreal mixedwood forest of northeastern Alberta, and has been the basis of controversy. Proponents of this emerging hardwood forest industry argue that it will strengthen the forest industry and diversify the economic base of local communities. Opponents are concerned with the scale of the operation and its effects on wildlife, fish, water quality and the general structure of the aspen community.

Extensive areas of Alberta will be affected ecologically by the scale of Al-Pac's operation. The annual allowable cut of aspen is between 2 500 000 and 3 000 000 m^3, and about 6 million hectares will be affected. Although the ground rules are still evolving, it appears that a two (or more) pass clear-cut system with a 40-70 year rotation will likely be used. This will result in a major change in appearance and structure of the aspen community, due to truncation of aspen successional stages and fragmentation.

Over-mature aspen/mixedwood forests represent only a fraction of the FMA. These stands are greater than 100 years old. They appear to be structurally complex (multiple tree and shrub layers, openings in forest canopy, and abundant snags and downed logs) and distinct from younger age classes. They are not desirable from a forestry viewpoint because of trunk rot, and staining resulting in poor market value. Despite this, overmature stands will be harvested to encourage replacement by younger, marketable trees. The removal or reduction in size of overmature aspen stands will affect those plants, birds, and mammals that depend upon them.

As well, principles of island biogeography indicate a strong relationship between the size of forest stands and their biodiversity. Fragmentation affects extinction rates through mechanisms such as radical changes in biophysical characteristics, increased inter-specific competition, violation of minimum viable area requirements, and increased importance of random extinction events. As forest stands are cut, it is important to understand how species richness and composition in the residuals stands will be affected.

Academics, wildlife management agencies, the forest industry, and the public are becoming more aware of the relationship between diversity and ecological stability, and the need to maintain diversity. Al-Pac has committed to developing an integrated resource management plan, that would minimize the effect of their forestry operations on wildlife. However, little detailed information exits for wildlife in their FMA area. Although ecological effects of timber harvest on conifer forests in Alberta have been examined, the effects of harvest on aspen forests, particularly overmature aspen/mixedwood, have not been fully quantified. Thus, the beneficial and adverse effects of large scale hardwood harvest remain largely unknown. By studying these processes in the early stages of Al-Pac's operations, managers have the opportunity to revise cutting strategies to address ecological concerns while maintaining an economically feasible harvest.

ALBERTA ENVIRONMENTAL CENTRE RESEARCH PROJECT

Overview

In view of the above concerns and considerations, the Wildlife Biology Branch of the Alberta Environmental Centre has initiated a five year study: "Effects of Clear-Cut Harvest on Diversity and Structure of Aspen/Mixedwood Communities in Alberta". The study will take an ecosystem approach, examining a variety of components of the aspen/mixedwood community including vegetation, invertebrates, birds, and mammals, as well as soil, weather, and snowpack characteristics within different age-class stands before and after clear-cut harvest. A major goal of the study is to provide management agencies and the forest industry with information which will assist in the sound management of Alberta's aspen/mixedwood forest resource.

Although initiated by the Centre, a number of other researchers are involved in this project. The departments of Botany, Geography, Entomology and Zoology of the University of Alberta are collaborating on a variety of aspects of this study. The proposed study has received verbal, logistical, and financial support from a number of agencies, including Alberta Forest Service, Lakeland Provincial Park, Alberta-Pacific Forest Industries Inc., Alberta Fish and Wildlife Division, Forestry Canada, and the Canadian Wildlife Service.

Research Questions

The research questions which will be addressed by this study are:

1) Are overmature aspen/mixedwood stands structurally complex?

2) Do overmature aspen/mixedwood stands support a diverse and unique assemblage of plant and wildlife species?

3) What will be the effect of clear-cut aspen harvest, as conducted by Al-Pac, on species diversity in residual stands.

Research Design

The research will be conducted in two phases. Phase I will be initiated in the winter of 1992, and data for each component of the study will be collected over a two-year period. The main objective for this phase is to compare structure and composition of young (15-30 years), mature (40-80 years), and overmature (>100 years) aspen/mixedwood stands and to identify species that are dependent on overmature aspen/mixedwood forests.

Phase II will run from 1994-1996, with the major objective being to examine effects of fragmentation on structure and composition of mature and overmature aspen/mixedwood stands. Al-Pac will cut half of the experimental stands during the winter of 1993-1994, in a manner similar to their actual cutting procedure. Although the ground rules are still evolving, it appears as though a series of 40 ha areas will be cut, separated by 40 ha of uncut forest. The experimental format for the study will be:

- 4 young stands (15-30 years)
- 4 mature stands (40-80 years)
- 4 overmature stands (>100 years)
- 6 randomly located sites/stands

Research Stands

Twelve research stands were identified for research purposes based on aerial reconnaissance, ground truthing, examination of stand structure, tree coring, and access characteristics. As well, all stands were $\geq$ 100 ha (based on Phase III mapping). Four mature and four overmature stands were selected in the Lac La Biche, Alberta area, and four early successional stands were located near Wandering River, Alberta.

The overmature stands are characterized by old trees, high degree of decadence, openings in forest canopy, abundant snags and downed logs, a well developed multi-strata shrub layer, and a developing conifer understory (5-10%). The mature stands are characterized by a closed canopy of aspen, healthier trees, minimal rotting of standing trees, fewer snags and downfall. Early stands are characterized by a high density of young trees with natural thinning occurring and a developing overstorey of aspen. Early stands developing as the result of cool fires contain snags and downfall; whereas those originating after hot fires are relatively devoid of snags and downed logs.

Within each research stand, six 100 m radius sample plots have been randomly positioned inside a buffer along the stand edge. Each sample plot centre is greater than or equal to 200 m apart from each other. Each sample plot centre is identified by a stake and marker, and access routes into the site are flagged.

Avian Component of Research

Avifauna contribute significantly to the biodiversity of the aspen/mixedwood community, and represent an important component of the study. The hypothesis associated with avifauna for Phase I of the study is:

- Avian communities of overmature aspen/mixedwood stands are distinct from and more diverse than younger stands. This difference in species presence and species richness reflects the greater complexity of vegetation structure, species composition, and dead wood in the overmature stands relative to earlier-aged stands.

and for Phase II it is:

- Aspen/mixedwood fragments will support different avifaunal communities relative to stands which have not been cut. The degree of difference will be dependent on the size of the residual fragment.

The following information will be collected to evaluate the above hypotheses: species composition, species richness, relative abundance, species diversity, life history traits (migratory status, foraging guild, nesting guild, habitat utilization), species-habitat associations, and fragmentation effects.

This study will examine only the effects of fragmentation at the size Al-Pac will be harvesting. Other studies are being developed by the University of British Columbia and the University of Alberta to examine the effects of different sizes of fragments on species diversity and species composition.

METHODS

Spring Breeding Bird Survey

The point count method without distance estimation will be used to estimate the composition and relative abundances of breeding birds within the stand. All sites within stands will be surveyed within a two-week sampling period, and sampling will be repeated three times during May and June. During each day of the survey period, two teams of two observers will alternate sampling in the various age-class stands. Surveys will begin 30 minutes before sunrise and will end by 10:00 a.m. to minimize daily variation in the detectability of birds. At each station observers will wait three minutes, recording site and weather information. Each bird seen or heard during a 10-minute interval. Will be recorded (each bird will be recorded only once). The information will be recorded onto a map using a standard series of symbols. Vocalizations of unidentified birds will be recorded using a parabolic microphone, and later identified by comparison to known calls from local birds. Following a count interval, observers will walk to the second site, and repeat the procedure. grouse and other species such as ravens and hawks seen or heard along route in and out of the sites will be recorded. The location of their nests will also be recorded, providing additional "presence/absence" data. Stands will be sampled in an ordered fashion each two-week period, and the order of sampling of sites within stands will be alternated each period. Surveys will not be conducted if wind speed is in excess of 15 kph or if a hard or persistent rain is in effect.

Nocturnal Owl Surveys

Nocturnal owl surveys will be incorporated into the study, though the survey technique which will best fit into the study has yet to be determined. Possibilities include: 1) walking transects along cutlines through the various age-class stands; 2) recording individuals from point count stations at each site (1 hr duration); or 3) setting out a recording device at the sites.

Winter Bird Surveys

Winter bird surveys will be conducted in conjunction with mammalian winter track counts at each site to reduce observer impact on the sites. All birds encountered (seen or heard) on route into and out of the sites, and during the track counts are recorded, as is duration of the survey. Surveys will be repeated 2-3 times each winter. A species list, and individuals per unit time, will be determined.

In Phase I of the study, species composition, richness, diversity, relative abundance, and life history traits will be compared across age classes of stands. In Phase II of the study, avian characteristics will be compared between fragmented, and unfragmented stands.

Snags

Relative abundance of cavity-nesting and bark-excavating species within stand age-classes will also be measured indirectly by quantifying cavities within and assessing foraging activity on trees and snags. Snags will serve as the main focus of sampling.

Snag and tree density will be determined from photometric techniques. Additionally, ten snags will be randomly selected at each site, and the following measurements taken:

- Species, diameter breast height (dbh), height, density, basal area
- Condition: alive or dead, upright or leaning
- Top condition: broken or intact
- Percent of bark on tree; number of conks on tree
- Number of decayed branches, stubs, or scars
- Decay type: heartwood or sapwood
- Rot class: very hard, hard, soft, rotten
- Cavities: types, number, height, dbh, size, occupancy

- Evidence of foraging activity
- Surrounding trees of snags

The four nearest trees to each snag will be identified, and height (ht) and diameter breast height (dbh) measured. If cavities are present, the same information will be collected as for snags. Data collected will provide information on: the number and size of live trees and snags in various age-class stands; differences in avian use of live trees versus snags; characteristics of snags and live trees which are consistent with the presence of cavities; and frequency of occurrence of cavities in relation to the size of trees and snags.

Bird-Habitat Association

Several vegetation parameters are considered to be important in determining bird species presence. The following will be measured at each site during Phase I of the study:

Trees: species, dbh, height, basal area, density, and canopy cover, height and depth

Shrubs: species, height, density, vertical cover and horizontal cover (0-0.5 m, 0.5-2 m., > 2 m)
Herbaceous: percent of cover graminoids, forbs, non-vasculars, litter, and bare ground, as well as overall height

Deadfall: frequency, size, rot class, foraging activity

Bird-habitat associations will be examined using multivariate statistical procedures.

ACCOMPLISHMENTS TO DATE

Research stands have been chosen and the sites established. Initial canopy measurements have been taken. Aerial photos have been taken of each site, and one winter bird survey has been conducted.

SUMMARY OF THE RESEARCH PROJECT

The research application of the study is to:

1) Provide resource management agencies and the forest industry with presence, abundance, and habitat-association information of bird species in the various age-classes of aspen/mixedwood stands

2) Forest harvest strategies could be adjusted to ensure that minimal areas of old-age class stands are retained, if over-mature aspen/mixedwood stands are distinct.

3) Cutting strategies could be modified to minimize impacts, should the cutting strategies of Al-Pac result in changes in community structure in the residual stand.

DISCUSSION

Question by Ms. Cumming: It might sound picky, but words, i.e., the way we define things, sort of reflect how we think about them. I have a real problem with the word over-mature. I just want to ask, over-mature for what? It seems to be a better concept to call the forest young, immature, mature and perhaps old rather than over-mature.

Response by Ms. Nietfeld: Yes, we can do that. You can either term it as over-mature or old growth.

Comment by Ms. Cumming: It is just a comment. It has a negative connotation to call something over-mature.

Comment by Mr. Thompson: Over-mature has a very clear definition. Biologists confuse the term over-mature. Over-mature is quite simply the stage in the stand development when the total biomass of the stands is decreasing. It is just a matter of semantics, and it is a matter of definition.

Question by Mr. Hobson: You mentioned being able to control the degree of isolation and size of these cuts. What about shape?

Response by Ms. Nietfeld: We really won't be looking at isolation for our particular study. We will be controlling size, because there will be basically 40 hectares cut and 40 hectares left. I am assuming that the way it works is on a two-pass system. I think Daryll Hebert may elaborate on exactly how Al-Pac may be cutting certain stands. I don't know if they will follow the configuration of the stand, or if they will cut strips through the stand. That definitely will affect how we look at the fragmentation part of it. It hasn't gotten to the stage where we can incorporate that.

Question by Mr. Euler: Have you decided yet what measuring tool you are going to use to measure diversity?

Response by Ms. Nietfeld: I guess you mean for the overall study of the birds?

Question by Mr. Euler: I am interested, because you didn't let us know what measuring tool you were going to use.

Response by Ms. Nietfeld: For diversity, we will probably be looking at some point on the Shannon-Wiener Index of Diversity. We will also be looking at species richness, relative abundance, and the differences in species composition. You may have the same diversity, but you may have totally different species or guilds making up that diversity, so that will only be one factor on how we actually look at the system.

Question by Mr. Pepper: I was wondering if you are going to pay any particular attention to natural diversity (i.e., aquatic and riparian areas or rock-out crops), in the landscape?

Response by Ms. Nietfeld: Basically, we are not. Some of the stands have small streams running through them. We have tried to get something that was fairly homogeneous, because we don't want to bring in all sorts of other factors. We would like to look at stands that are relatively even. There is some variability. There is always going to be variability, but we wanted to try to minimize certain things, like rock-out crops or things like that with the stands. We won't be dealing with the riparian area, but that is something that does tend to have a very high species richness.

Question by Mr. Pepper: I was just wondering whether you are eluding those or trying to incorporate them?

Response by Ms. Nietfeld: No. We can only handle so much, so they basically won't be included.

Question by Mr. Savard: I have one small question. Could you have taken another approach? Assume that there was a difference. Between the age classes and then design your exploitation strategy around that. If you show that there is no difference, then it is easy to have more area. The way you seem to have designed it, you assume that there is no difference. Look where you find the difference, and if you find a difference, you have a problem. You have to cut back on to what you were planning to harvest.

Response by Ms. Nietfeld: Do you want to run through that?

Response by Mr. Savard: Okay. A strategy you or Al-Pac could use is, assume that there is a difference between the age classes. If there is a difference, this is how much we could harvest. Do your study at the same time, and if you find the difference, you are all right. Follow your first strategy. If you don't find the difference, then you have got more wood to cut. The problem that they encounter almost everywhere when they find a difference have a setup quota that they have to cut, and it is a big fight to try to incorporate.

Response by Ms. Nietfeld: We are starting out at the beginning of their operations, and we wanted to get two years preharvest versus two years postharvest information. We wanted to come up with something while they were still in the early stages of development.

Question by Mr. Savard: So, they haven't set the amount that they are going to cut each year?

Response by Ms. Nietfeld: It is supposedly three million cubic metres each year.

SESSION 3

LANDSCAPE ISSUES - "SCALING UP" FROM THE STAND TO THE ECOSYSTEM

Chair: Richard Bonar
Weldwood of Canada
Hinton, Alberta

MANAGING BIODIVERSITY IN FORESTS AT LARGE SPATIAL AND TEMPORAL SCALES

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ABSTRACT

Foresters have traditionally managed forests at the spatial scale of a stand, and at the temporal scale of a rotation. To manage forests for biodiversity requires operating at the larger scales of landscapes and patterns of disturbance and succession. The spatial scale of cutting should be based upon the spatial scales of natural disturbances and/or the spatial requirements of organisms, both of which vary widely, rather than converging on a simple compromise of moderate-scale cutting. The temporal pattern of cutting should strive to maintain a variety of different age classes of stands, including stands that are older than typical cutting cycles. Recognizing and maintaining old-growth stands will require development of regionally appropriate definitions for each type of forest ecosystem. Large-scale management of forests also requires addressing questions of land-use allocation. These can be conceptualized as a triad model that seeks to balance: 1) intensively managed forest plantation; 2) forest reserves with no timber harvesting; and 3) extensively managed, multiple-use forests.

This paper is about space and time, largely at a conceptual level, although there are some specifics relevant to the boreal forest that be shared with as well.

The leap in scale of perception from a flea to a person is only four orders of magnitude. That is, the fraction of a millimetre of the human hair to the few centimetres of an aspen tree is only four orders of magnitude. The word "only" is used because the range of scale at which organisms select their habitats is much wider. Compare a range of scale from the few square centimetres that define the habitat of some small invertebrates, or of plants with very small home ranges defined by their roots and crowns, up to the hundreds, even thousands of square kilometres that constitute the home ranges of some of the large carnivores, wolf packs and the like. This is eight to twelve orders of magnitude versus the merely four orders of magnitude that was referred to earlier.

This leap in scale is particularly important when it can be reduced to a simple question. When does black and white become gray as perceived by different organisms? Figure 1 shows two orders of magnitude from the world as seen on the left by a small warbler, and on the right by a kestrel. In this figure, each of black and white cells represents one hectare. Think of the black as being a mature forest and white as an area that has been recently clear-cut. On the left, a black-throated green warbler looking at this habitat might be able to see adequate habitat to establish a territory. It would see a one hectare cell of black, and reproduce adequately. On the other side, however, a kestrel looking at the same landscape, but at a different scale, might not see black and white. The Kestrel would not be able to choose the white of open habitat that it needs. It might see a mixture that is not appropriate for its habitat need.

There are two key ideas here. First, whether or not the forest is diverse spatially depends upon the scale of perception of the organism that we happen to be talking about.

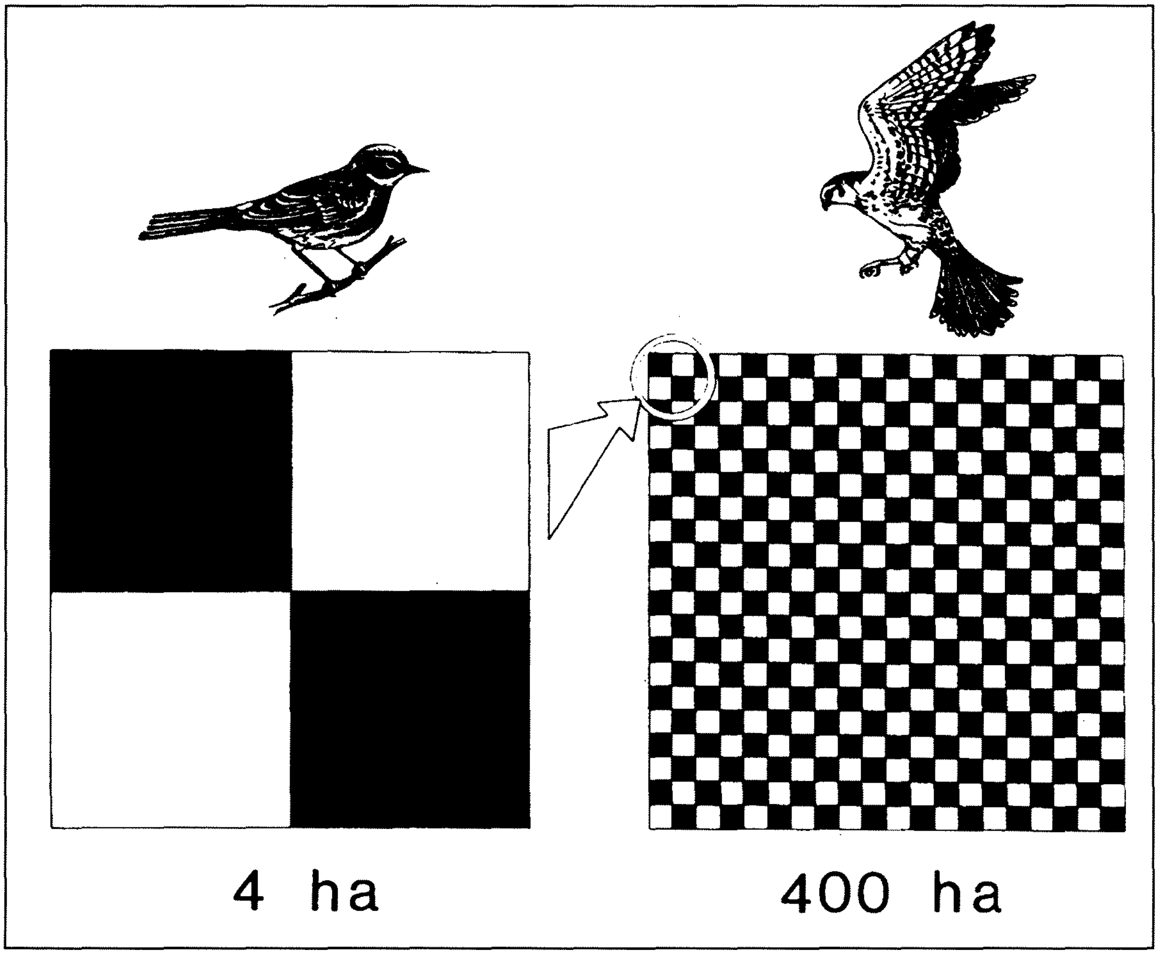

Figure 1. In each block the individual cells represent 1 ha of 60-year-old forest (black) or 5--year-old forest(white). The left figure represents the scale of perception of a warbler; the right figure represents the scale of perception of a kestrel. Reprinted with permission form "Wildlife, forests, and forestry" by M. Hunter, Prentice-Hall, 1990.

Secondly, the need for spatial diversity varies among organisms. There are some habitat specialists represented in Figure 1; there are some species that need black habitat, some that need white habitat, and species that have to have both black and white habitat. There are also some habitat generalist species that can use black, white or gray habitat.

Some predictions about the relative diversity of different types of forest can be made if those two ideas are accepted as premises. At the smallest, a scale at which an individual tree might be habitat, for a bark beetle, for example, probably the most diverse forest is going to be one that is of uneven age structure, relatively old and of mixed tree species composition. This is the kind of forest that is readily maintained by individual tree selection harvesting.

On a somewhat larger scale, where many small birds and mammals and reptiles select their habitat, the most diverse forest is probably going to be one that consists of a mosaic of different stands: some young stands, some old stands, some conifer stands, some deciduous stands and mixed stands, et cetera. This is the kind of mosaic that might well be maintained by patch cutting, cutting in the order of a hectare or so.

Government agencies, large landowners and industrial owners need to think about management at very small scales and intermediate scales and even the very large scales that are created by clear-cuttings.

Clear-cutting is often heavily criticized. It is equivalent to deforestation in a lot of people's minds. More and more people, however, are recognizing that clear-cuts do not generate non-habitat. There are certainly species of butterflies, sparrows, that are associated with these early-successional ecosystems. Moreover, what is now a large clear-cut will eventually become a large tract of mature forest, habitat for a species that need large tracts of forest. In short, management at a variety of different scales should be advocated, ranging from individual tree selection on up to large clear-cuts.

How is this area going to be allocated to different points along this scale? There are two ways to approach this. One is to think in terms of the size scale of different organisms. In many instances management should be focused towards small species rather than large species, simply because there are more small organisms in the world than there are large organisms. This is true both in terms of total numbers and numbers of species. For example, there are only seven species of bear in the world, but there are hundreds of species of mice. Similarly the total world population of bears is not more than a million or two, whereas there are billions of mice in the world.

A second way to answer this question of allocation of scale is to think in terms of matching patterns on the landscape. Examining the size distributions of features like watersheds, lengths of rivers, and islands will find that many of them have a negative exponential distribution. Bringing it closer to issues of relevance to forest management, one finds the same patterns in the size of treefall gaps, forest fire sizes, and soil unit sizes.

Taking this idea and applying it to a hypothetical distribution of cut sizes might suggest a distribution of 100 000 small openings, individual tree cuts of 0.01 ha, 10 000 group selections of 0.1 ha, 1 000 of 1 ha patch cuts, 100 of 10 ha small clear-cuts, and 10 of 100 ha large clear-cuts. The result is a hypothetical distribution of equal area allocation across a fairly wide distribution of cut sizes.

The next question that needs to be asked is: What should the upper limit of clear-cut sizes be? There are three ways to answer this question. One is to think in terms of the whole management area, the size of the area one is managing. There is no room for large clear-cuts when managing a very small area because some age diversity should be maintained by having cuts distributed through time. This is more of an issue for small landowners rather than industrial or government ownerships.

Another possibility is to think in terms of the home-range requirements of those species of organisms that are going to have the largest requirements for uniform habitats. Some of the large carnivores, mountain lions, bears, wolves, et cetera, have the largest home-range sizes. These species, however, tend to be habitat generalists. Amongst some of the smaller carnivores, such as goshawks, pine martens, and kestrels can be found species that have relatively large habitat requirements (often in the hundreds or thousands of hectares), and these species need relatively uniform habitat requirements.

The third possibility for deciding maximum clear-cut sizes is to think in terms of natural disturbance regimes. Where individual treefall gaps in a forest are the largest disturbance that ever happen, perhaps individual tree cuts are as large as they should get. On the other hand a different upper limit is appropriate in boreal forests with their large fires.

Recapitulating, there have been three key points. One, forests should be managed at a variety of different scales. Two, effort should be allocated about equally across that scale. Three, the upper end of that scale should be determined by one of three things, the size of the management unit, the size of home-range requirements (for example, some of the organisms like small carnivores that need large tracts of uniform habitat), or natural disturbance regimes.

There are three things that have not been covered here that need to be emphasized. First, there is nothing about exact numbers. The distribution examples given (e.g., one-hundredth of a hectare up to 100 hectares), are hypothetical. The second thing not addressed are the issues of fragmentation and placement on the land of (e.g., small-scaled management in ecologically-sensitive areas and larger-scale management in places that are accessible to transportation). Finally, clear-cuts are not the same as natural disturbances. Careful thinking about all the residual organic matter left on a harvest site, whether that is slash, downed logs, snags, seeds, seedlings, or remnant trees is needed. This is an important topic and its important is acknowledged, but will not be discussed in this paper.

When foresters and wildlife biologists discuss issues of scale and cutting, they often come down to a sharp dichotomy. The industrial, forestry side says, "We have to have large-scale management because small-scale management is not economically feasible." The environmental community says, "Large-scale cuts are destructive; they are deforestation," and we end up with a compromise of many moderate-sized clear-cuts. I would argue that such a landscape has compromised its spatial diversity rather markedly, and it is far better to think in terms of a diversity of scales rather then compromises.

This paper (to this point) has been a summary of materials from chapters in a previous book (Hunter 1990). I want not to share with you some material from a paper in press in Biological Conservation (Hunter in press) that specifically deals with boreal forest fires. Data on boreal forest fires in Quebec (Payette *et al.* 1989) and Labrador (Foster 1983) show that natural fire-size distributions in an area uninhabited by people generally follow a negative exponential pattern. More important is the total area of fires of different size classes. These data suggest that most of the landscape is being burned by very large fires (between 10 000 - 100 000 hectares in size). The overall mean fire size was 12 000 hectares for the Labrador study area and about 7 000 hectares for Quebec. Proposing to the public that 10 000 to 100 000 hectares should be the range of clear-cut size you would meet with enormous negative reaction. Even to a broad-minded philosopher, a clear-cut that reaches to the horizon and is going to last throughout most of their lifetime is hard to accept. Essentially it stretches forever and it lasts forever. What is to be done?

Here is a compromise approach. Imagine a 400 hectare tract that needs to be half cut. Two extreme possibilities are to cut half of it in one 200 ha block or to cut half of it in a series of 200 one hectare blocks. There is a profound difference in terms of the relative amount of edge generated in these two instances. There are two kilometres of edge between cut and forest around the 200 ha cut, 76 kilometres around the 200 small cuts. (Forest fragmentation and edges are issues that have many people worried, but most of the information about forest fragmentation is being generated in agricultural landscapes with small patches of forest sitting amongst fields. Cowbirds and skunks and crows, et cetera are causing problems for breeding birds in these patches. The extent to which these data can be applied to forest dominated landscapes is very much open to debate.) The compromise is

Figure 2. In this hypothetical forest, a period of forest succession is followed by an equally long period of climax forest. Where during succession is biological diversity greatest? Which half of the figure, A through E, or E through F, will have the greatest diversity: Reprinted with permission from "Wildlife, forests, and forestry" by M. Hunter, Prentice-Hall, 1990.

to talk about large cuts that are clustered together and separated by buffer zones, as opposed to extremely large clear-cuts.

Clusters of moderately large cuts offer a number of advantages. First, if there is a problem with forest fragmentation, it would tend to minimize it by concentrating the openings in a relatively small area. Secondly, residual strips between cuts would be reasonably analogous to the unburned skips that often occur in fires. These are often long, linear features along lakes, streams and wetlands, and could be left behind simply by leaving buffer zones in riparian areas. They could serve as travel corridors for species that need them, as seed sources, and as buffers to the aesthetic perceptions of people. Thirdly, this system would allow, to the extent that forest fire control is not complete, the very large-scale disturbances to still take place.

Temporal issues

Think of time in a circle because of the patterns of disturbance and ecological succession, and the associated comings and goings of a variety of different species. During a forest wildlife management class students are asked when during ecological succession (A to E in Figure 2), is biological diversity greatest? Students familiar with empirical studies of ecological succession usually answer "soon after a disturbance." Students who have read some ecosystem theory literature are more likely to answer "during the climax/state". Students familiar with the intermediate disturbance hypothesis say half-way between disturbance and climax. There are arguments to be made across the board, in other words.

No one knows what the answer is. There has not been a forest anywhere in the world that has been measured for total biological diversity (i.e., with all of the invertebrates, microbes, et cetera). Just for the sake of argument, assume that it might be at the climax state, Letter E. At the climax, there is a relatively tall ecosystem with all the vertical stratification of microclimates and physical niches that provide habitat for a lot of different species. In many climax forests, there are small gaps starting to appear where dead trees have fallen down. There will new microenvironments in these gaps, even some early-successional species if the gap is large enough. Finally, at the climax stage, there will be the largest amount of deadwood with all the incredible variety of organisms associated with it. A favourite statistic is about two families of wood-boring beetles, (*Buprestids* and *Cerambycids*). They have more species globally than all of the birds, all of the mammals, all of the reptiles, and all of the amphibians multiplied times two.

Accept for the sake of argument that climax forests do have the greatest biological diversity. Does that mean that a forest landscape that is entirely comprised of climax stands will have the greatest diversity? The answer is no diversity. Where in Figure 2, A through E, or E through F, does the greatest biological diversity occur? The answer is obviously A through E. All the species coming and going through successional processes will collectively be more diverse than the set of species associated with any one stage.

Here is the nub of the issue. Many people from the forestry community, and many wildlife managers, especially game managers, like to emphasize all of the species that are coming and going through the early part of succession. They are right. There is a great diversity of species during this phase. On the other hand, environmentalists worried about endangered species emphasize the rarity of climax forests, and all their associated species in landscapes that are being managed for timber.

Next, the focus will be on what an old-growth forest is. Old forests are over-mature, senescent, decadent, or they are primeval, pristine, ancient, virgin. The adjectives say more about value systems than they do about what is actually happening in the forest. The only applicable definition is a very simple one: old forests are relatively old. Relatively old has to be determined for each different type of forest ecosystem. Sweeping generalizations cannot be made. There are too many people that have uncritically accepted ideas coming out of the Pacific Northwest that "relatively old" is over 250 years old. We need to use a series of different age criteria and apply the appropriate one to a given ecosystem.

Here are five possibilities:

1) Has the stands species composition stabilized? This is the classic idea of a climax ecosystem.
2) Has the stand reached a point of no net accumulation of biomass? This does not mean that the stand has stopped growing, only that growth and death are now equal.
3) Is the forest older than the average interval between natural disturbances severe enough to lead to succession? This criterion may be the most relevant to boreal forests. Clark (1988) analyzed charcoal strata in northern Minnesota forests and found a fire periodicity of about 44 years. Finding a stand that was significantly older than this period, perhaps because it was on an island or otherwise sheltered by physiography from fires, would mean for that landscape it would be a relatively old forest stand.
4) Average longevity is probably somewhere between what the pathologists call pathological longevity, the age at which trees start to have many problems with disease, and the maximum recorded longevity.
5) The last and finally the least-restricted definition would simply be: Has the forest's current annual growth declined below the lifetime mean annual growth? This is the way cutting rotations are determined. It simply says any forest that is older than the age at which we would normally cut it, is an old forest.

The other issue that might be considered is whether or not a forest is relatively disturbed. The following questions could be asked:

1) Has the forest ever been cut? Is it virgin, in other words?; and 2) Has the forest ever been

converted to another type of ecosystem? Large areas in much of New England and eastern Canada were agricultural land then reverted to forest. They would not be considered potential old-growth stands, because of their conversion to another type of ecosystem.

A triad perspective

Earlier, this paper referred to people's perspectives: clear-cuts are good, clear-cuts are bad; the world is black, the world is white; everything is hot, everything is cold. Many arguments become polarized very easily. There are very few words representing the middle, medium, intermediate, moderate, and other generic words. Forest management should be thought of not in terms of a polar construct, but rather as a triad, a three-prong approach. In part one of the triad trees should be grown intensively, making silviculture an analogue of agriculture. In these sites there would be few worries about what happens in terms of biodiversity issues, the same way there is little concern about biodiversity in the middle of a cornpatch.

In part two of the triad, reserves should be recognized as legitimate uses of forest land. It is arrogant to think that we can manipulate forests in ways that can maintain all of their ecological values. Some forests must be set aside to provide these values, and to be subject to natural disturbance regimes.

Thirdly, there is a place for multiple-use forestry, forests where there is a balance between timber production recreation, wildlife, water, and other values. The allocation of land should not be equal among these three components; that is; going to vary from ecosystem to ecosystem, and among political and economic systems. Viewing management as a triad, and recognizing that each of these elements has legitimacy, will likely be more fruitful than arguing in terms of polarized constructs [see Hunter and Calhorn (In press); Seymour and Hunter 1992].

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DISCUSSION

Comment by Mr. DesGranges: It is just a comment I want to make about the difference between the cycle of fires in Labrador and in Quebec. The Quebec data, I suspect, comes from the southern boreal forest where there is fire control; while in Labrador, as in northern Quebec, usually the fires go wild.

Response by Mr. Hunter: The Quebec data are from an area that Payette *et al.* specifically state is outside of human fire control.

Question by Ms. Hannon: In the first part of your talk, you suggested that we should manage, for example, the size of the clear-cut areas depending on the size of the management unit. I wonder that if the size of management units follows a negative exponential distribution, then you are going to have a lot of people managing with very small clear-cut sizes. At the upper end of the scale where you have very few large units, you are going to get all sorts of social considerations coming in to limit the upper size of clear-cuts. You are really going to be pushing that or truncating that distribution down to very small clear-cut sizes. I wonder if it is better for managers instead of managing on their own, very small local scale, to look a little more generally and maybe manage as groups of management units or something. Related to that then, your suggestion that you should put more effort into small animals because there are more of them; they tend to have higher population densities; tend to be more resistant to catastrophic population changes, and thus, are more resistant to extinction. In a sense, even though there are more of them, maybe we should be allocating it that way. Larger animals need more management, so how do you balance those concerns?

Response by Mr. Hunter: Two very good points. Your first point on the negative exponential distribution of land ownership size is not an issue I had thought about before, but you are absolutely right. My response to that would be just what you suggested. I have a slide, that I chose not to show for lack of time, of a woodlot floating over a landscape, with which I make the point that it is very important to look beyond the boundaries of individual ownerships, and make decisions across property boundaries.

As to the second issue on the small animals, I also agree with you. My figure has a fudge factor that I would have elaborated upon, if I had more time. Although organisms follow a negative exponential distribution in terms of body size, the hypothetical distribution that I put up was not a negative exponential one in terms of allocation of area. There was equal allocation for large and small units because I recognize, as you do, that in many instances large organisms are in worse trouble than small organisms. This issue is covered in a second fashion. At the smallest scales of management, individual tree selection, and at the largest scale, big clear-cuts, at both ends of the continuum, you will have relatively large blocks of habitat that many larger organisms will perceive as uniform. I usually make this argument in the context of the fragmentation issue. At both ends of the spectrum you have the least amount of fragmentation and the largest tracts of uniform habitat. It is in the middle, when talking about small clear-cuts and patch cuts, that you have the greatest amount of habitat fragmentation.

Question by Mr. Brace: Malcolm, maybe because you are addressing this as an academic, you could explain the position that Franklin and Spears have taken on New Forestry with respect to the west coast forests. What is the academic or intellectual rationale for that approach to those old forests?

One of the things that is being said is that they are addressing the old-growth issue in the way that forestry operations are conducted.

Response by Mr. Hunter: The basic idea of New Forestry is that we should think of forests as ecosystems and manage them as such, and view the derivation of products as secondary; rather than thinking of forests as commodity farms that we can manage with as little damage to the ecosystem as possible.

In terms of the specific things that Franklin and others are advocating, for example, what they call green retention (i.e., leaving trees and snags in the middle of cuts and snags), they are trying hard to make a case for the multiple use part of what I call the triad. They worry that in the Pacific Northwest they will end up with a forest landscape that is entirely wilderness reserves or industrial plantations.

In the State of Maine, and I suspect this is true of much of boreal Canada, that middle part of the triad is the biggest one. We have very few industrial plantations; perhaps 2-8 percent of our forest landbase is really intensive management. On the other hand less than two percent of Maine's forests have been set aside as reserves. Over 90 percent is in the middle part.

In New Zealand's government forests (80% of all forests), less than one-tenth of one percent fall into multiple use of native forest. Virtually all production comes from exotic plantations. Ninety percent of all of the government native forests have been set aside as reserves (Hunter and Calhoun in prep.).

Comments by Mr. Brace: I think that addresses part of the issue. There is an effort to relate that concept to boreal mixedwoods, and it has given a lot of people problems in trying to understand how to interpret it.

Question by Mr. Hunter: Why? How is it causing people problems?

Response by Mr. Brace: As you suggest, we don't have large amounts of plantations; apparently there isn't a danger that we are going to lose some major ecosystems, at least not in the way they are looking at it. I think we do have to be concerned about maintaining good, big chunks of representative ecosystems.

Question by Mr. Moller: When you were depicting, Malcolm, your block of 400 hectares, it was proposed that you leave half of it as a leave area, and cut the other half in three different small pieces with buffers between them. Did you depict the leave area as a reserve, or did you expect to cut it in the next cycle, whenever that might be?

Response by Mr. Hunter: Usually, I would expect it to be cut in the next cycle. In some cases, I would expect it to be left as a reserve. I didn't really have a major assumption about that. I assumed if this was a managed landscape, an extensively-managed landscape, that most of that would be cut on a subsequent entry.

Question by Mr. Moller: How could you cut the area, and have a balance of age classes and areas of old forests?

Response by Mr. Hunter: If you are entering an area that has never been cut and bring it into management for the first time, maintaining a broad age class diversity might be difficult in the beginning. I assume that you would wait half a cutting rotation before you cut the leave area. Once you have a landscape with a balance of age classes, then maintaining that distribution is relatively easy.

Question by Mr. Bortolotti: I have a problem with the use of fire models to determine the upper limit of clear-cut size. The very large fires are not just burning evenly through one age class or one type of stand that would be where you would want to commercially harvest. It is going through a variety of age classes. These larger fires are burning through all sorts of different forest types. You may have a 10 000 hectare burn through several different forest types and several different ages. I don't see how that can then be applied to one large area that is in an even-aged stand. If some of these birds are coming back, obviously you need the forest, but even then, the soil moisture conditions and whatever are different. Fifteen percent of the area is not going to be burned. It doesn't seem reasonable to presume that the large disturbance, which is a landscape disturbance, is equivalent to disturbance, in a commercial forest.

Response by Mr. Hunter: You are right. A large fire can cut across age classes and types, but there are often some types with a predilection to burn, and others are not like that. It is not quite as simple as I portray, or quite as chaotic or random as you portray it. However, I think the bottom line is that after the fire has taken place, apart from differences in soils and sites, things are going to be somewhat uniform in terms of site conditions certainly. There are differences but in both cases you have a major disturbance.

Question by Mr. Bortolotti: I just don't see it as quite being that equivalent. I mean, if a large fire is burning through a few different forest types, therefore you are having a large disturbance, but it is not equivalent. Then saying let's take that large disturbance, and apply it to just one forest, of an even age.

Response by Mr. Hunter: Let's imagine you had a 12 000 hectare fire 100 years ago, and now you wanted to go in and cut that 12 000 hectares that is now 100 years old. If you made the boundaries of your cut coincide with those of the 100-year-old forest, wouldn't that satisfy the issue?

Question by Mr. Bortolotti: Well, I am a little leery about these acreage figures. Are they complete burns where all the trees are removed?

Response by Mr. Hunter: No, they are not. I tried to make the point that there are substantial skips out there. The figure that was given yesterday, was 15 percent. I have seen higher figures, 25 percent and more, and that certainly needs to be recognized.

Question by Mr. Bortolotti: Well, if those large burns actually do come back to an even-age forest and we are just taking off that replacement with a new forest, that certainly makes sense, but I don't think that is really necessarily what always happens. You may have 12 000-hectare burns that end up in a couple of different forest types, and what might be more realistic in that area, may be a cut of eight or 10 000 ha or something like that.

Response by Mr. Hunter: I have no arguments with that. Obviously you have got to tailor the cuts to the specific site conditions. You can't just sit in Ottawa and draw 12 000-hectare squares on the map.

Question by Mr. Bortolotti: I guess my question is, Do you have any idea of relating actually what the disturbance size could be and what the realistic size of a subsequent cut might be? Since we can't use that 12 000, ha figure we have to scale it down, what kind of magnitude scaling might be reasonable?

Response by Mr. Hunter: I haven't really thought about that except to say that it should be tailored and that issues of skips have to be recognized.

Question by Mr. Welsh: Gary started my point, but I would like to continue on this discussion a little bit further, because I think it is quite important, particularly in the situation that we have in the boreal forests where discreet forest stands in fact are perhaps much more obvious than you might be used to in areas further south. If you take the 12 000-hectare burn, then that might well be composed of (if we imagine an average stand size of 100 hectares), 100 to 150 different stands, many of which are quite distinct and unique.

If we consider the forest ecosystem classification I was discussing yesterday, they might in fact represent a broad range of ecosystem types, but I agree with you completely that it is quite important to try to create temporal diversity on the landscape that mimics what would have occurred naturally.

I think what we need to be very careful about, assuming that we cut five or six or even 12 000 hectares, is giving enormous attention to the range of forest ecosystem types that we want to come back there. I think that part of the problem we have had to date is that in fact it has been assumed that it was quite acceptable to convert all the black spruce or jack pine or in fact have a relatively simply regeneration goal for that landscape. We need to have a regeneration goal for that 12 000 hectares that in fact takes into account all of those sub-units, that other pattern. We are really talking about two distinct patterns. One, the fire pattern; and the other, the forest stand pattern. In some cases, depending on the landscape, they will be of the same scale. In the case of the boreal forest, the temporal fire landscape is big patches, and the forest ecosystem type is small patches. We need to manage for both of those things.

Response by Mr. Hunter: That is a very important point and I agree with it. The way to deal with it, not to make it sound simple, is to have the cutting regime mimic fire to the extent feasible in terms of, this issue of all the organic matter left behind. Seeds, soil and organic matter, et cetera, would be left behind after a fire. That might, for example, involve burning the slash (which is easier said than done). Then if we can assure that the regeneration processes after a clear-cut are as close as possible to the regeneration processes after a fire, it would bring back that complement of different stands that you emphasized today and in your talk yesterday. I agree with it very much.

MANAGING FOR LANDSCAPES AND BIODIVERSITY: ACHIEVING THE IMPOSSIBLE

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ABSTRACT

This paper describes a generic policy hierarchy and illustrates how large organizations guide the activities of their members. Biodiversity and ecosystem management are shown to be specific examples of the general process. Suggestions for a policy framework, strategies, and specific objectives for biodiversity landscape and ecosystem management are outlined for discussion purposes. As Natural Resource agencies change their management pattern and process, the ideas of biodiversity and ecosystem management will become even more important.

The development of a management system that promotes and achieves biodiversity in a landscape setting is an arduous task that requires enormous effort and discipline. The purpose of this paper is twofold: to illustrate how a policy hierarchy that involves biodiversity could be constructed; and to provide examples of the components of a landscape management system based on ecosystems, biodiversity and sustainability. Although the difficulty of developing a landscape approach based on biological principles should not be underestimated, a careful and thoughtful framework can be built that will "achieve the impossible".

A PERSPECTIVE ON TERMS

Several terms are essential to a discussion of the building of a management system based on biodiversity and ecosystems. Without common definitions, discussions of this nature often lose meaning. In this paper, a variety of terms are used that may have different meanings to different people. In order to minimize confusion over semantics, the context and meaning of the words used here have been included. There is more than one way of approaching these problems, and the thoughts here are provided in the spirit of promoting discussion and, hopefully, in assisting in the improvement of forest management for all wildlife.

Biodiversity is a concept much like justice, friendship or love. It is best understood when put in the context of a goal worth striving for because of its importance. The concept of justice is, in some ways, analogous to the concept of biodiversity. Governments establish systems of justice in order to protect people and to allow human society to function. The Earth, in order to function, must maintain an appropriate level of biodiversity. Without justice, human society could not exist. Without an appropriate level of biodiversity, the Earth cannot continue to exist.

Ecosystem management must be viewed in a similar light. People try to manage ecosystems even though a full understanding of the consequences of management activities, and the ability to manage all components of an ecosystem will always be difficult.

Sustainable development is the third concept in the currently popular lexicon of managers and policy makers. While a great many words have been expended to define sustainable development, the core thought is simple, perhaps so simple that the idea confounds everyone. "If an activity is sustainable, for all practical purposes it can continue forever" is the basic definition taken from the Second World Conservation Strategy Project (IUCN/UNEP/WWF, 1991). This simple idea of managing resources to insure that no damage has been done to the systems that support the resources has been around for a long time. No one interested in using the resources of the earth wants to destroy the systems that provide the resource.

Landscape management in this paper refers to developing a management system that is set in the context of large blocks of land.

DEFINING BIODIVERSITY

There are many definitions of biodiversity, and they all essentially have the same meaning. The following meaning, cited in Probst and Crow (1991), is often used:

BIODIVERSITY

> Biological diversity refers to the variety and variability among living organisms and the ecological complexes in which they occur.

However, what Robert Szaro said at a Biodiversity Workshop in Missoula, Montana (1990) is regarded with favour.

> "I have heard over and over again the questions: How can we define biodiversity? or What is biodiversity? To me these are simply nonsense questions. Intuitively we all have a base level of understanding of the meaning of biodiversity. We may not individually be able to come up with a textbook definition but there is no real mystery about it. When we have concerns for biodiversity we are saying we have a concern for all life and its relationships. As arguably the most intelligent species on earth we have a responsibility to try as much as possible for the continuance of all forms of life. What is biodiversity? Perhaps the simplest and at the same time most complete definition of biodiversity as formulated in the Keystone Biodiversity Dialogue Report is that "Biodiversity is the variety of life and its processes". Biodiversity means we must expand our view to encompass not just forests but riparian systems, ponds, alpine meadows, grasslands, and deserts as well."

The concept of biodiversity is both simple and complex, a true paradox. At one level it contains a very simple idea: the sum total of all life in its many forms. At another level, this complexity is truly awe-inspiring and almost beyond comprehension.

Measuring Biodiversity

Concepts are often difficult to measure and no one has been able to devise a quantitative way to measure biodiversity. In order to measure it, a formula would have to include "all the variety and variability" of living organisms. Clearly a single formula of that nature seems impossible. People world-wide are working on this problem and in the future the concept of biodiversity may be measurable. Vane-Wright *et al.* (1991), for example, illustrate how taxonomic relationships can be incorporated into value judgements that reflect biodiversity, and the value of biodiversity in ecosystem function.

For purposes of resource management, biodiversity is usually broken into three diversity components, which can be measured in many circumstances. This breakdown is effective because it begins a process of management that can be discussed, and illustrates the decisions that must be made.

GENETIC DIVERSITY

Genes are the biochemical packages passed on by parents that determine the physical and biochemical characteristics of their offspring. Modern genetics permits measurement of these genes that allows people to understand some of the genetic diversity that occurs in nature.

SPECIES DIVERSITY

Species diversity is usually measured in terms of the total number of species and the number of individuals within each species; all within discrete geographical boundaries.

ECOSYSTEM DIVERSITY often refers to two things:

1. the variety of species within different ecosystems, (more diverse ecosystems contain more species), and

2. the variety of ecosystems found within a certain biogeographical or political boundary.

Sometimes three terms are used:

alpha diversity is the number of species within an ecosystem;
beta diversity compares the diversity of two or more ecosystems, usually measured along a line; and
gamma diversity measures the landscape diversity of ecosystems.

DEFINING ECOSYSTEMS

Many of the same thoughts apply in thinking about ecosystem management. Definitions of ecosystems abound as with definitions of biodiversity. A favourite definition developed at an Ontario Ministry of Natural Resources workshop is:

Ecosystem

An ecosystem is a system of physical, chemical and biological components interacting within a defined space and time.

The classic definition coined by Tansley in 1935 remains valid.

"... the whole system (in the sense of physics) including not only the organic complexes but also the whole complex of physical elements forming what we call the environment."

Ecosystem management involves changing or managing some of those components. The problem is not in understanding the terms, but in knowing how to manage ecosystems effectively in the real world. People have conflicting demands and managers can never know enough about the ecosystems they manage. In fact, much of the time, relatively little is known about the ecosystems being managed.

Despite the difficulties, however, some practical and feasible ways of dealing with these concepts are available.

DEVELOPING A MANAGEMENT SYSTEM

The most important question is: How can biodiversity and ecosystem concepts be incorporated into a landscape management process in order to achieve the goal of sustainable development?

In most modern organizations a policy structure or hierarchy governs the actions of people who help achieve the mandate of the organization (Figure 1). There is considerable variation in the terms used to describe the parts of the structure. There is almost always, however, a similar pattern to the hierarchy of policy and strategy that guides everyone.

The process often begins formally with one or more of the following:

1. A set of principles by which the organization guides the behaviour of its members;

2. Some statement of values that are important to the group;

3. A mission and/or a vision statement;

4. A goal statement and/or strategic objectives.

In recent times in Ontario, these statements taken together have been called a Framework. At present a Forestry Policy Panel is developing a Comprehensive Forest Policy Framework to provide the broad strategic direction for forest management into the 21st century. Sometimes these statements, however, taken together are called a Strategy. The World Conservation Strategy and the National Forest Sector Strategy are examples of effort that provides overall direction to major human organizations.

For the Ministry of Natural Resources as a whole, DIRECTION '90s (Ontario Ministry of Natural Resources 1991) is a Comprehensive Framework for Natural Resources Management.

In DIRECTION '90s, Principles are included, for example:

All life is connected, from the fungi in the soil to the birds in the sky. Human activity that affects one part of the natural world should never be considered in isolation from its effects on others.

A Goal is given:

To contribute to the environmental, social and economic well-being of Ontario through the sustainable development of natural resources, and Objectives are listed[1], for example:

To ensure the long-term health of ecosystems by protecting and conserving our valuable soil,

Following the establishment of a Framework, most organizations develop specific policies, accept certain strategies, and formalize specific objectives. Rules and guidelines are often devised for evoking specific behaviour from its members.

Policies are explicit expressions of how an organization goes about its business.

Strategies refer to the actual activities that implement the policies.

Specific objectives are the measurable targets that people strive to achieve.

Rules and Guidelines set limits that cannot or should not be exceeded.

Tactics often describe, in a general way, the more specific activities that are used to achieve the goal and strategic objectives.

The Justice Example

An example of a policy hierarchy from an area outside of resource management might be helpful to illustrate how cooperative systems are developed to guide behaviour. The justice system in Canada provides a good parallel idea to help understand these concepts.

[1]In Direction '90s these are called Objectives, but the way they are written they are really Strategic Objectives. Objectives are usually more specific targets that are measurable and that the organization tries to achieve.

POLICY HEIRARCHY	EXAMPLE
COMPREHENSIVE FRAMEWORK (Big picture strategy)	SUSTAINABLE FORESTS
Principles or policy principles	A Canadian Commitment
Goal statement	World Conservation Strategy
Strategic objectives	
Value and/or vision statements	
POLICY	
The first step to define what will be done	The importance of old growth in forest management
STRATEGY	
Instructions to members concerning what an agency or group will do	General guidance in managing old growth
SPECIFIC OBJECTIVES	
Measurable targets that people try to achieve	The amount of old growth needed
GUIDELINES AND RULES	
Explicit instructions about what to do	Old growth regulations

Figure 1. An example of the major components of a policy heirarchy.

Principles — The justice system in Canada relies on the principle that laws are necessary to maintain an orderly society. (This is only one principle among many others in the justice system of Canada.)

Strategic Objective — The purpose of the justice system in Canada is to treat everyone the same regardless of race or economic status.

Policy — The policy of most law enforcement agencies is to wear distinctive uniforms in order to insure that the general public recognizes those people and their role in society.

Strategies — Speed limits will be enforced most strictly during rush hour in the Toronto Metropolitan Area.

Specific Objective or Target — To reduce the death rate from automobile accidents by 10 percent

Laws, rules — Speed limits on Highway 400 from Toronto to Barrie will be 100 km per hour.

A BIODIVERSITY POLICY HIERARCHY

A policy structure for biodiversity and landscape management would include the same elements. First a comprehensive framework or strategy for biodiversity management must be developed. This framework should include statements of principles, some value statements, and an expression of goals and strategic objectives. The overall guide then must be followed by policy, strategy, strategies specific objectives, and some rules and guidelines. Developing this process will be difficult and never ending. It is important to coordinate and guide how people conduct management activities.

The following sequence illustrates some of the elements needed in a biodiversity-landscape management policy structure.

Biodiversity Management and Landscapes

Examples of some components that may be part of a biodiversity and landscape policy hierarchy could include, for example:

Vision — It is important to maintain a rich tapestry of forests across the Canadian landscape that sustain a diversity of wildlife. (Canadian Council of Forest Ministers 1992).

Healthy forest ecosystems are essential to the health of all life on earth. (Canadian Council of Forest Ministers 1992)

Goal — To maintain and enhance the long-term health of our forest ecosystems, for the benefit of all living things both nationally and globally, while providing environmental, economic, social and cultural opportunities for the benefit of present and future generations. (Canadian Council of Forest Ministers 1992).

Principles — All life is connected, from the fungi in the soil to the birds in the sky. Human activity that affects one part of the natural world should never be considered in isolation from its effects on others. (Ontario Ministry of Natural Resources 1991).

Strategic Objectives — The objective of this Strategy is the maintenance of an undiminished diversity of self-sustaining wild life populations, (Wildlife Working Group 1991).

To conserve the natural diversity of our forests, maintain and enhance their productive capacity, and provide for their continued renewal. (Canadian Council of Forest Ministers 1992).

To ensure the long-term health of ecosystems by protecting and conserving our valuable soil, aquatic resources, forest and wildlife resources as well as their biological foundations (Ontario Ministry of Natural Resources 1991).

An over-simplified summary of the policy hierarchy for a justice system might be:

Goal — The goal of the justice system is to ensure that people are protected and treated fairly throughout Canada

One of the major problems in developing a policy hierarchy is that too often, organizations are reluctant to move below the framework or strategic level. Most of the controversy occurs at the action level where the written framework has to be translated into actual work that has the intended effect. Statements that clearly define the policies and specific strategies that management agencies use are not abundant, and are not easily available.

The following examples of a policy hierarchy are intended to fill in the blanks. It is only when the entire set of statements is seen together, however, and in context, that managers can translate good ideals into management actions. (see Appendix I).

Policy — The Ministry of Natural Resources will attempt to mimic the natural diversity of plant communities through its timber management activities.

No species will decline as a result of timber management.

Strategies — Staff who mark trees for cutting will leave trees standing, which have value for wildlife even if they do not have timber values.

Timber technicians will record wildlife values as they conduct timber cruises.

Specific Objective or Targets — In Central Region, five snags per hectare will be left for wildlife values. Plant species diversity in all forest management units should not be reduced as a result of timber harvest.

Rules or Guidelines — The common measurement of diversity that should be used is the Shannon-Wiener Information Index.

The following are examples of components that might be contained in a policy hierarchy for ecosystem management.

Ecosystem Management

Principles — All life is connected, from the fungi in the soil to the birds in the sky. Human activity that affects one part of the natural world should never be considered in isolation from its effects on others. (Ontario Ministry of Natural Resources 1991).

Strategic Objective — The objective of this Strategy is the maintenance of an undiminished diversity of self-sustaining wild life populations, (Wildlife Working Group 1991).

To ensure the long-term health of ecosystems by protecting and conserving our valuable soil, aquatic resources, forest and wildlife resources as well as their biological

	foundations. (Ontario Ministry of Natural Resources 1991).
Policy	It is the policy of the Ontario Ministry of Natural Resources to give equal emphasis to all values of the forest (e.g., wildlife values are equally as important as timber values).
Strategies	The Forest Ecosystem Classification will be the basic tool used to identify the ecosystem units which will be the basis for ecosystem management.
Specific Objective	No ecosystem unit (FEC type) will be eliminated from the landscape as a result of management activities.
	Resource management plans should strive to maintain all the ecosystems units that are present in the managed area in approximately the same proportion as are currently present.
Guidelines	Mixed conifer stands will not be converted to pure conifer stands.

POLICY DEVELOPMENT

Large organizations develop their policy agenda over relatively long periods of time. Government organizations, for example, must respond to a variety of people with diffuse and varied sets of values. These overall guides to the behaviour of large groups of people are seldom developed quickly or without disagreement.

As well, the process is constantly changing and probably will never be static. Confusion can occur when strategies or specific objectives change before the framework changes. Many of the changes that the Ontario Ministry of Natural Resources has accepted as a result of the Class Environmental Assessment for Timber Management are at the strategic and specific objectives level. This occurred because most of the discussion at the Hearings focused on tactical issues like silviculture techniques or the size of buffer zones. The changes accepted so far are closely aligned with a new policy framework for forest management that has not yet been developed. Therefore, there can be some difficulty in understanding how changes at the tactical level fit into a new framework.

Another problem for managers is that most of the issues addressed at the framework level are the kinds of general statements that are relatively free of conflict. Few will argue, for example, that all values in the forest are important, and that forests should be managed for more than timber production. At the level of guidelines, rules, specific objectives and strategies the arguments can become intense and heated.

Suppose the continued existence of a sawmill is dependent on cutting old-growth red and white pine. Accept, momentarily that the officially accepted specific objective in Ecosystem Management is "No ecosystem unit will be eliminated from the landscape as a result of management activities." This almost automatically raises a conflict. Can both ideals be pursued? Can both old-growth and sawmills exist, in sustainable forestry?

The main purpose of developing clear statements in a hierarchy of policy is to let everyone know how a management agency will achieve its mandate. Management is never an easy process and is made harder by the complexity of both modern human society, and the difficult problem of living carefully in a fragile world. Yet a balance must be achieved. People want to know how Resource Managers are going to achieve this balance. The whole process of developing these statements, which will realize long-lasting benefit is in itself a challenging task. All who work in this field should find the challenge intriguing and be pleased to be part of finding a solution.

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DISCUSSION

Question by Mr. Savard: I was very surprised to see the use of the Shannon-Wiener Index for plant biodiversity. They are moving away from it in managing for biodiversity for wildlife and birds. Malcolm Hunter in his introductory speech made a good picture of the way to manage for biodiversity that stresses more the diversity between habitat. I find it very dangerous to take that approach for plant biodiversity. I think you are going to hit a wall.

Response by Mr. Euler: What would you use?

Comment by Mr. Savard: The same approach as is used for birds, a top-down approach, that looks looking at the scale, and the species. It would be a policy that would say that no species is going to disappear within a unit area. Then decide on the relative abundance of your species that varies on local, regional needs, or abundance of those species, because the diversity index is not used very much anymore. It used to be a nice concept, and it was all based on relationship, but because it makes the relative abundance in the number of species, you are never sure what is driving the index. You are not too sure what it measures.

Question by Mr. Euler: A very thoughtful point, embedded deep in this discussion. I believe we have to measure something. If the measure is "no species decline" will that be acceptable?

Response by Mr. Savard: Not decline, but disappear.

Question by Mr. Euler: Okay, so what you are suggesting as an alternative is that no species should disappear?

Response by Mr. Savard: Yes.

Comment by Mr. Euler: I would find that difficult, The species can decline substantially. The only criteria is it doesn't disappear. I find that unacceptable. We have to have measures that measure something more than that. I don't care whether it is a Shannon-Wiener Index, or another one. I have only used it here as an example. It doesn't matter to me. I do think we need something. We need it, because our critics have to be able to look at our management activities and ask, did you reach your goal. We have to be able to say yes, we did, or no, we didn't. That is how I react to that. If we measure our success species by species, the task will be impossible.

Question by Mr. Diamond: I have a couple of comments about the biodiversity index. A few years ago, all the studies correlated so highly with the species number that you weren't actually doing anything by the statistical manipulations to move from S, the total number of species, to an H bar with the diversity index. One thing that we haven't heard much of is viability analysis, which in an animal population level is quite well established. Regarding population viability analyses, the technology is developing. It seems to me what we should not be aiming at a single index figure for a particular group. You have to track that. You have to define how much can it decline over your management period. What is a statistically significant decline? You get problems that would be outside the public domain, because they wouldn't understand it. An ecosystem viability analysis would force decisions about the probability of maintaining a viable ecosystem to a decided point in time. It is a stochastic calculation of how viable this system is, and over what length of time. It is not very deterministic. It forces those making the decisions to decide what level of confidence they can expect and realistically achieve over what level of time in terms of maintaining a particular diversity of ecosystem over a defined spatial management unit. Do you think with the experience in Ontario with the public participation process that an approach like that has a chance of going anywhere?

Response by Mr. Euler: Not a chance.

Comment by Mr. Diamond: I was afraid you would say that.

Response by Mr. Euler: I will never tell a member of the public that they don't need to understand some aspect of what we are doing. Whatever you use has to be understandable to people. You can't manage in any other way. My concern about your suggestion is that people really won't understand it and our decision-makers won't understand it. They won't have a clue what you are talking about.

Comment by Mr. Diamond: Ten years ago in that community nobody understood this picture of biodiversity index. There is a certain amount of new indication in going from a species-level approach to a stand-level approach to an ecosystem-level approach. There is a lot of education and learning to be done by ourselves.

Response by Mr. Euler: Yes, very thoughtful point.

Comment by Ms. Hannon: I think you are underestimating the intelligence of the public. In many issues to do with for example, health or pollution, you can get public groups who are not scientifically educated. They can learn about these things, and then go on to become pressure groups to make change. I want to have a nice neat number that (I can say whether we are in good shape, or in bad shape. It is not telling you what you need to know. I think by getting too simple that you are really going down the wrong track. I agree with Tony that you have to get into some sort of viability indices. It is a little more complex, and it is going to take a little more work on the ground. I think you are underestimating the intelligence of even the people in the higher echelons of government. They need people to explain these concepts to them.

Response by Mr. Euler: Okay, a thoughtful point. From my experience for example, in the Timber Class EA, which is a major event in Ontario, most of the discussion revolves around trying to reduce things to simple numbers; like a limit on clear-cut size. That is what the pressure groups are saying. I am speaking from that experience which may be different from other experiences. I recognize that it can be wrong, but that is where the pressure is to reduce everything to simple and measurable parameters. Whether that is a number or not is clearly debatable. It has to be measurable in real world terms with something that people can understand. That is my experience.

Comment by Mr. James: I think one of the reasons why the system encounters problems in terms of policy-making, setting policy and strategies, and the reason why arguments to develop at an intense level is simply, because we do not have the knowledge. We don't have the facts when it comes to managing forests in Canada. I think we need a massive research effort in forest ecology in this country. Then, we can determine where we are going, and whether we are going to use the Shannon Index. I think we are fooling ourselves to think that we are going to make educated choices about forests with a data base that we have now. It is truly pathetic.

Response by Mr. Euler: Yes, I know. I sympathize.

Comment by Mr. Clark: Managers want to manage and often become frustrated when scientists say, you don't know enough. How long can we wait? As forest management progresses with some variation in cut sizes and so on, there is an opportunity for people with good research skills to provide some of the answers. It is a matter of getting it organized. I think there are opportunities for scientists and researchers to come together with the forest managers to achieve some real gains.

Response by Mr. Euler: It is a classic debate between what to do when we don't know enough, and essentially, there is not enough money to do more research.

Question by Mr. Fitzsimmons: I would like to ask a question. You were saying how important it is for government agencies to set up parameters to measure over time and set objectives. You had an ecosystem 2 000, and it broke down water, wildlife, fish, timber. I am wondering if there are things that you have to measure, i.e., things to do with soil, atmosphere, and precipitation. I think a lot of the major forest declines in eastern North America and Europe have been linked to changes in atmosphere, changes in soil, and chemistry. We are missing all that by looking at this mega-structure of timber, wildlife, fish and water use, in terms of water consumption. I wonder if the Ministry is looking at setting up measurements for these kind of things, not just structure, but ecological functions, and nutrient cycling?

Response by Mr. Euler: What I showed is just an example of where we are at the moment. Clearly the points you made have got to be addressed. At the moment in Ontario, they haven't been addressed.

Question by Mr. Bonar: I have a comment and a question, related to that. You were talking about the process and the hierarchy of decisions that you are going to have to make. Have you analyzed the initial system and looked at what we do now, what our resources are spent on, and related that to what you think you would like to do, and if reallocating your resources might allow you to do some of that?

Response by Mr. Euler: The Ministry as a whole hasn't. However desirable that might be, the answer is no. We got caught in a timber environmental assessment. Lawyers are saying, tell us what you do, and then we are going to defend you against the onslaught. The other side says, you are bad news, and we are going to get you. That sets up an atmosphere that is inimical to better management and more logical management. That is not what you would do with your household budget. That is not what you would do if you worked for a timber company, and you were involved in cutting. Your suggestion is the kind of thing you would do, if you were in a situation where you had more control over what you do. We have lost control in this very public process. Critics are shouting, do it my way, and it really is inimical to a thoughtful management process.

Question by Mr. Bonar: Are you able to go back to those critics when they come to you with an alternative and say, please back up and give me your goals and objectives that relate to this alternative?

Response by Mr. Euler: That may not be in the interests of the critic to do that. Their interest is in forcing you to move in some certain direction. There are political tactics by which that can happen. At the Environmental Assessment, for example, some parties want limits on clear-cut size, and they want to impose that on us. They are pushing a very political agenda. You may have remembered the headlines in the Globe & Mail. The headline read, "Clear-cuts Half the Size of P.E.I." Commuters read that on the way to work that morning in Toronto. The thrust of the article was that the Ontario Ministry of Natural Resources is devastating the northern Ontario forest. When you get into that kind of situation, it is impossible to be rational.

APPENDIX I.

A BEGINNING POLICY HIERARCHY FOR BIODIVERSITY MANAGEMENT IN A FORESTED LANDSCAPE SETTING.

NOTE: This is not intended to be a complete set of items that would make up an approved policy hierarchy. However, it does suggest a number of elements that should be included. A final version, e.g., would contain more elements of timber production.

GOAL To maintain and enhance the long-term health of our forest ecosystems, for the benefit of all living things both nationally and globally, while providing environmental, economic, social and cultural opportunities for the benefit of present and future generations. (Sustainable Forests: A Canadian Commitment)

VALUES

The forest heritage is part of the past, the present, and the future of Canada as a nation.

It is important to maintain a rich tapestry of forests across the Canadian landscape that sustain a diversity of wildlife.

Healthy forest ecosystems are essential to the health of all life on earth.

Continued economic benefits must be maintained for the communities, families and individual Canadian who depend on the forest, both for their livelihood and way of life (Canadian Council of Forest Ministers 1991).

STRATEGIC DIRECTIONS

Conserve the natural diversity of our forest, maintain and enhance their productive capacity, and provide for their continued renewal;

Improve our ability to plan and practice sustainable forest management;

Increase public participation in the allocation and management of forest lands, and provide an increase level of public information and awareness (Canadian Council of Forest Ministers 1991).

SUGGESTED POLICIES

Public and private forest management agencies will include measurable objectives for the state of the forest ecosystems in their forest management plans.

Forest management agencies will use an ecological classification system in developing forest management plans.

All agencies will complete a system of protected areas by the year 2000.

Forest management agencies will include specific measures of diversity in their forest management plans.

Forest inventories will include information concerning wildlife, fish, non-commercial plants and wilderness values.

SPECIFIC OBJECTIVES

A Forest Ecosystem Classification (FEC) System will be developed by 1995.

Forest Management Plans will be based on FEC units after 1995.

No ecosystem unit will be eliminated from the landscape as a result of forest management activities.

Between stand diversity will not be reduced by more than 50% in a forest management planning area.

No ecosystem type will be reduced to less than 20% of its current area or increased to more than 500% of its current area in a forest management plan.

Featured species management will be employed to create plans for game species and endangered species.

Silvicultural techniques will be employed, wherever possible to produce a commercial tree species composition that is as close as possible to the original forest.

No species shall decline, over a large area, as a result of timber management activities.

RULES AND GUIDELINES

Five snag trees per hectare, as a minimum will be left for wildlife purposes.

All forest managers will use the Shannon-Wiener Information Index as one measuring tool to measure plant species diversity. (This does not mean that managers cannot use other measuring formula as well, it just means that everyone will use at least this one.)

Forest management plans will be available for public inspection at least six months before the plan is approved.

NEST PREDATION AND FOREST BIRD COMMUNITIES IN FRAGMENTED ASPEN FORESTS IN ALBERTA.

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ABSTRACT

The effects of aspen forest fragmentation on neotropical migrants breeding in woodlots surrounded by agricultural land near Athabasca, Alberta were examined. Larger woodlots had more species, but isolation of woodlot and vegetational structure did not influence number of species. Some species thought to be area-sensitive in eastern deciduous forests were found in small woodlots in Alberta. Predation rate of artificial nests was not influenced by woodlot size, but nests in woodlots with lower canopy cover suffered higher predation losses. Results from studies in eastern deciduous forests may not be extrapolated to boreal forests and more in-depth studies are required on the mechanisms of species loss in small woodlots.

INTRODUCTION

The circumpolar boreal forest is one of the largest remaining tracts of forest on earth and it is becoming increasingly fragmented by agriculture and forestry. Although there has been research done into effects of fragmentation on bird communities in boreal systems; this has been done mainly in Europe on predominantly coniferous stands (e.g., Haila *et al.* 1987). There has been little work in boreal mixedwood stands that are dominated by trembling aspen *(Populus tremuloides)* and balsam poplar *(P. balsamifera).* Recent technology in the pulp and paper industry will lead to large blocks of *Populus* stands being cut. Potential impacts of this cutting on wildlife are unknown; but mature *Populus* forests will become rare and increasingly fragmented.

Fragmentation of eastern deciduous forests has led to decreases in some bird species, particularly neotropical migrants (Robbins *et al.* 1989b). These decreases have been attributed to area, isolation and habitat effects (Lynch and Whigham 1984; Freemark and Merriam 1986) and negative edge effects such as increased nest predation and parasitism (Brittingham and Temple 1983; Yahner and Scott 1988). These patterns may be different, however, in boreal forests that are naturally a mosaic and where disturbance is a major factor (Welsh 1987).

This paper reports on a 1991 study of the effects of habitat fragmentation on birds in mature aspen-dominated boreal mixedwood stands surrounded by agricultural land near Athabasca, Alberta. The objectives of the study were to determine the species composition of the avifauna in aspen fragments of different sizes and isolation, and to determine levels of nest predation in aspen fragments of different sizes.

METHODS

Fifteen woodlots of mature aspen ranging in size from less than 1 ha to 140 ha (Figure 1) plus an area of continuous habitat (>1 000 ha) were chosen in an agricultural area near the Meanook Biological Station (54°37'N, 113°20'W), near Athabasca, Alberta. Fragments were chosen so that they were similar in topography and size of aspen, and had minimal disturbance of the understory by cattle grazing. The main crops in the area are alfalfa and barley, and cattle grazing is common. Brown-headed cowbirds (*Molothrus ater*) were observed in all fragments. Potential nest predators observed in the area were blue jays, crows, black-billed

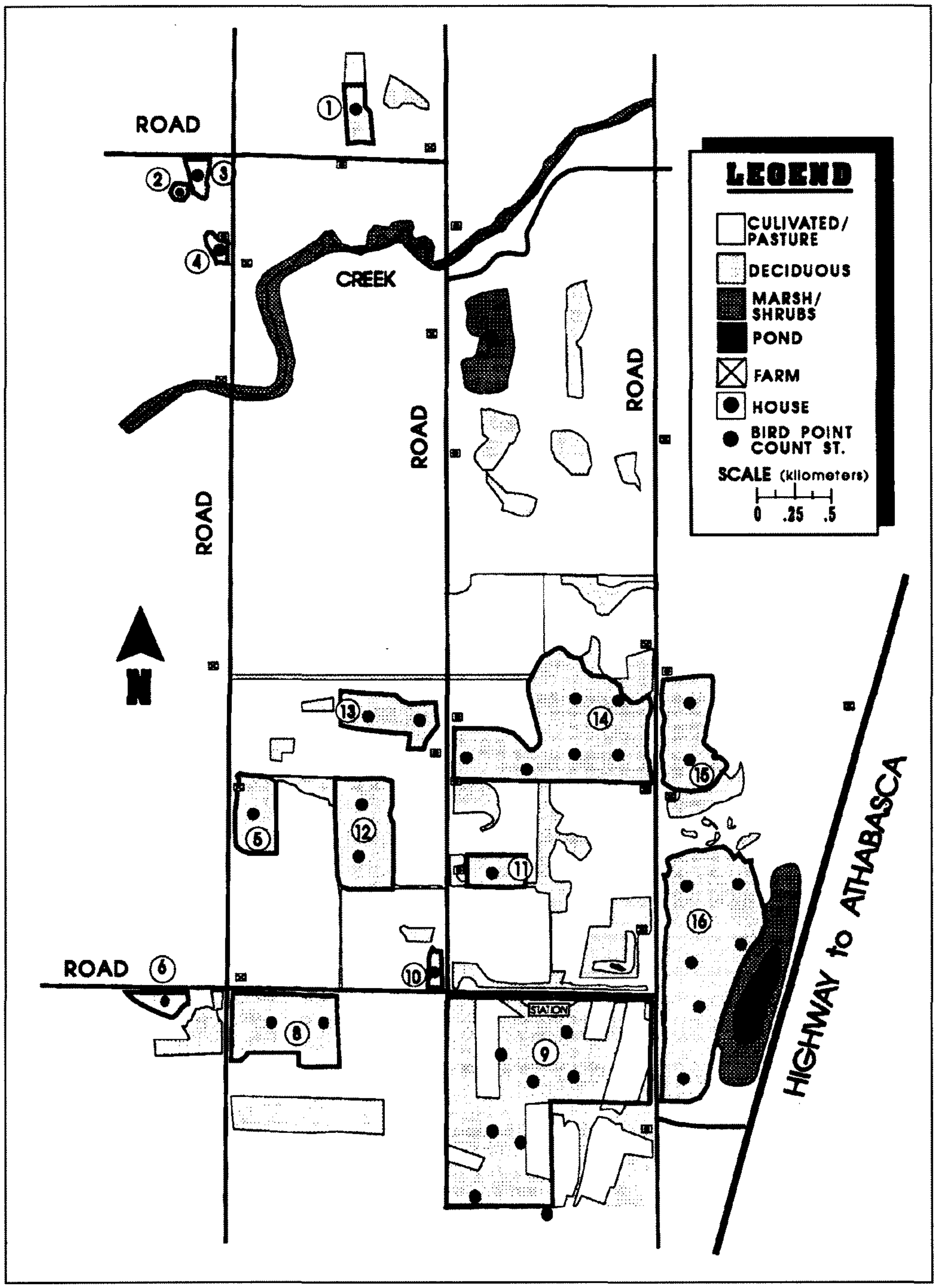

Figure 1. Study area south of Athabasca, Alberta showing woodlots used in the study (outlined in bold).

magpies, ravens, red squirrels, coyotes, weasels, and mink.

Breeding bird surveys

Breeding birds were surveyed in each fragment from stations placed at least 500 m apart. Small fragments (1-15 ha) had only one station; fragments 15-40 ha had two stations and fragments >100 ha had 6-8 stations. The continuous area (Narrow Lake) had 11 stations. Calls of singing males were recorded from stations starting 30 min prior to dawn until 2 hr after dawn. Numbers of individual males were counted, but we did not estimate distances as prior experience indicated that these estimates were not accurate. A bird was also recorded if it was seen. Counts began one minute after arriving at the station and continued for 6 min. Sampling continued if new individuals were encountered in the sixth minute, but this rarely happened. Only two observers were used and 25% of counts were made by both observers concurrently. A tape recorder was used to record unfamiliar songs for later identification using Peterson Field Guide records. Bird counts began 7 May and continued until 20 June. Each fragment was surveyed 3 times. We reversed the order of stations each time we did a survey.

Nest predation experiment

Transects with stations 30 m apart were erected through each fragment. Two transects were placed at Narrow Lake. Two types of artificial nests were erected at alternate stations: ground nests placed at the base of trees or shrubs baited with two "pewee" brown chicken eggs; and cup nests placed between 60 cm and 1.5 m high in small trees or shrubs. The cup nests were wicker baskets of the type used by aviculturalists, lined with dry grass and baited with two *Coturnix* quail eggs. Nests were placed between 22 and 28 May and were checked every 7 days for 21 days. A predation event was recorded if at least one of the eggs was taken or penetrated.

Vegetation measurements

Vegetation was measured at each nest station, each song station, and at some randomly chosen stations in each fragment. The following variables were measured:

Canopy cover: A black and white photograph was taken straight up from the centre of the plot using a single lens reflex camera. Photos were printed to 4X6 inches. A 4 × 6 grid of 50 evenly spaced dots on a transparency was placed over the photograph and the number of times a dot covered part of the canopy was recorded. This value was multiplied by 2 to get percent canopy cover.

Canopy height: Average canopy height was estimated using a clinometer at 30 metres away from the centre of the plot.

Herb height, percent herb cover, and herb species: These were measured in a 1 m × 20 cm plot centred in the middle of the vegetation plot.

Shrub height, density and species: These were measured for live shrubs using the point-quarter method. The quadrants were centred in the middle of the vegetation plot.

Tree density, dbh and species: These were measured using the same quadrat as for shrubs. Standing dead and live trees were included.

RESULTS AND DISCUSSION

Breeding Bird Survey

We identified 42 species of breeding birds in the aspen woodlots, but here I only deal with neotropical migrants (Table 1). As in other studies (Whitcomb *et al.* 1981; Blake and Karr 1984; Freemark and Merriam 1986), there was a highly significant species-area relationship (Figure 2, R^2=70, P=0.0001). The continuous forest (Narrow Lake) had a similar number of species to fragments of 100 ha and larger (14-18

Table 1. Neotropical migrants heard in dawn counts of singing males in aspen woodlots near Athabasca, Alberta (edge species excluded)

Species heard	Species heard in fragments <10 ha	Species heard only in fragments >10 ha	Species heard only in fragments > 20 ha	Species heard only in fragments > 40 ha
Least flycatcher	X			
Alder flycatcher		X		
Western wood peewee	X			
House wren	X			
Swainson's thrush		X		
Solitary vireo			X	
Warbling vireo			X	
Red-eyed vireo	X			
Tennessee warbler		X		
Yellow warbler	X			
Black-throated green warbler				X
Back-and-white warbler		X		
American redstart	X			
Ovenbird		X		
Connecticut warbler				X
Mourning warbler		X		
Common yellowthroat			X	
Yellowrumped warbler	X			
Western tanager				X
Rose breasted grosbeak	X			
Northern oriole	X			

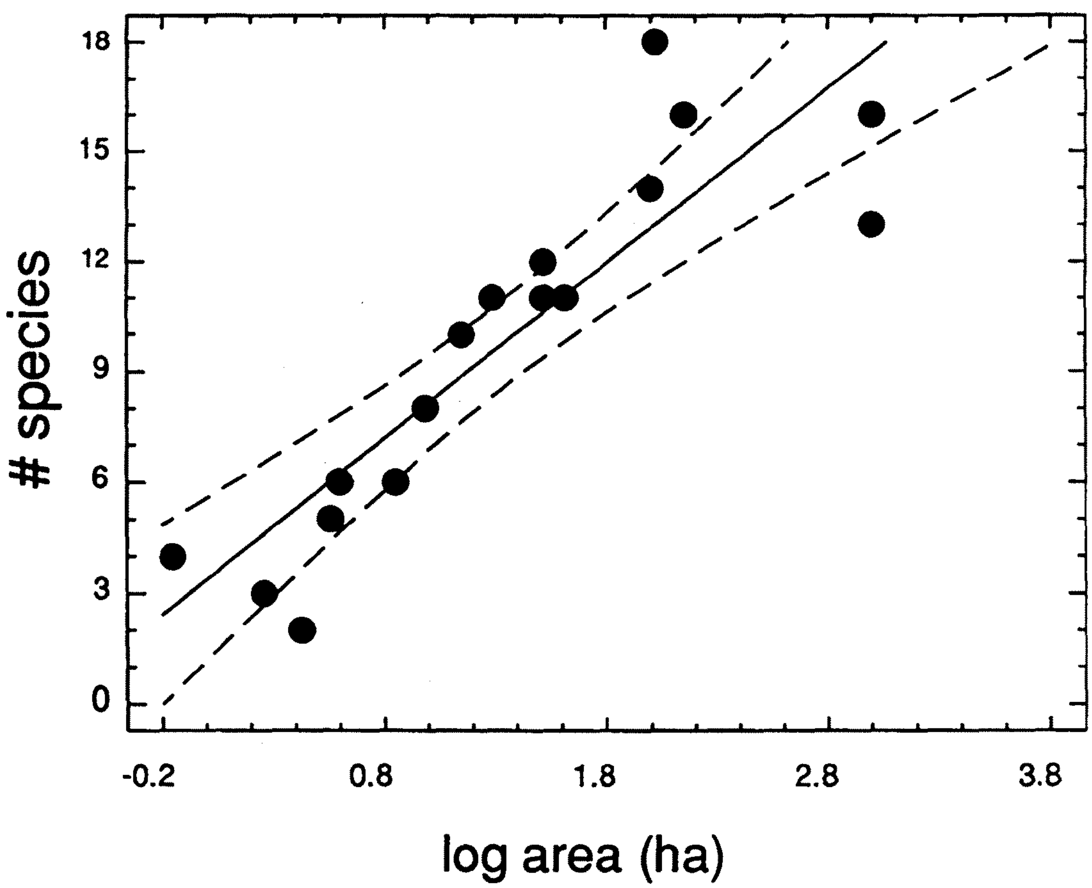

Figure 2. Species area curve for neotropical migrants in woodlots.

species), but species loss occurred in fragments smaller than 100 ha; reaching a low of 4-6 species in fragments of 7 ha and smaller. The number of species in a woodlot was not related to isolation (distance to the closest woodlot of equal or greater size, Figure 3). A stepwise multiple regression, including area, isolation, and all vegetation variables, found only area to be significant.

Some species that in eastern deciduous forests are considered "area-sensitive" were found in very small woodlots in Alberta. For example, black-and-white warblers in two studies in Maryland were found in woodlots larger than 70 and 208 ha (Whitcomb *et al.* 1981; Robbins et al. 1989a). In this study they were found in woodlots as small as 14 ha. Ovenbirds are another species thought to be highly area-sensitive in the east and yet I found them singing in woodlots of 14 ha and larger. Welsh (1987) also observed supposed area-sensitive species in small blocks of habitat in boreal mixed wood forests in northern Ontario. Further studies are required to determine whether these birds are in fact breeding in small woodlots, however, these results suggest that species' requirements may not be the same across their range. Boreal forests are naturally patchy as disturbance in the form of fire and insect outbreaks are major ecological forces. Local populations of birds may be adapted to some level of fragmentation, or perhaps some of the negative edge effects observed in eastern deciduous forests are not

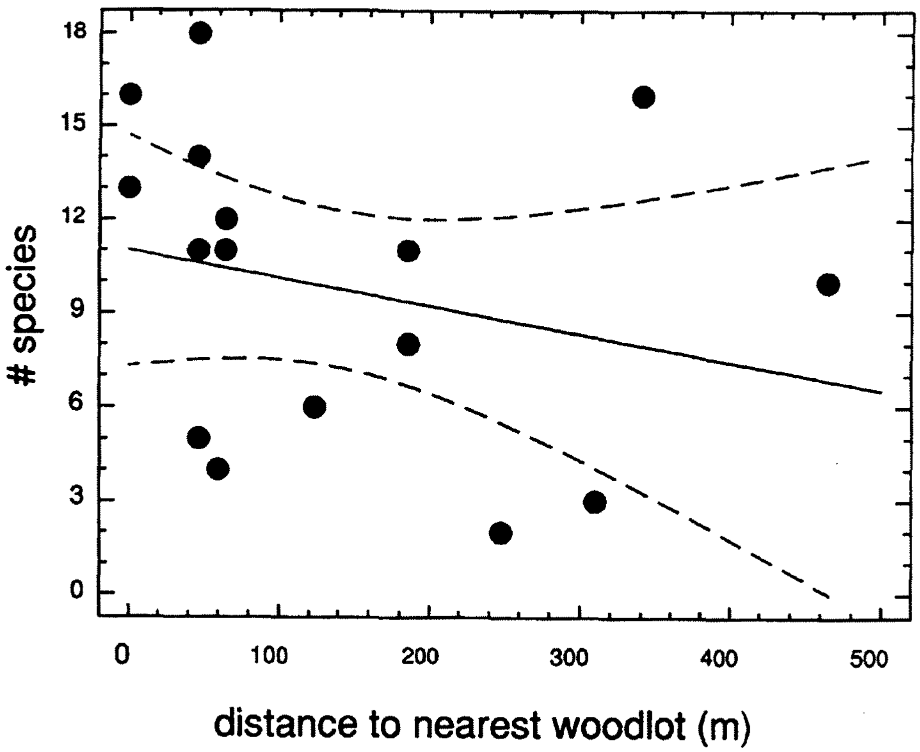

Figure 3. Number of species of neotropical migrants found in woodlots of varying levels of isolation.

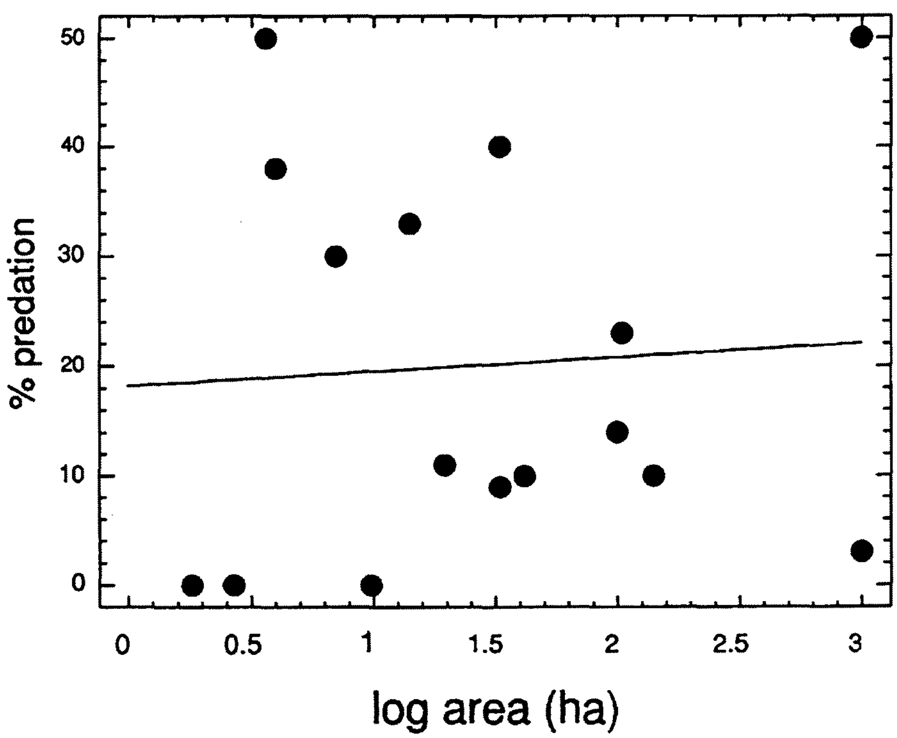

Figure 4. Percent predation of artificial arboreal nests in woodlots of varying size.

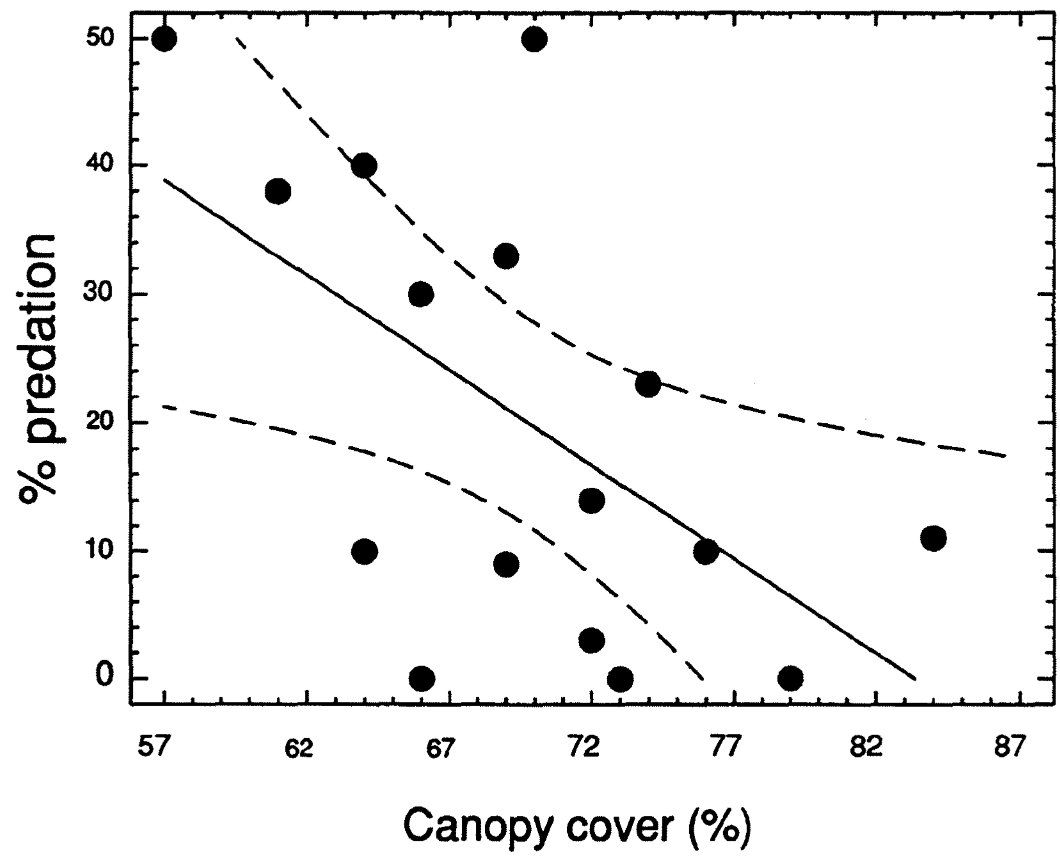

Figure 5. Percent predation of artificial arboreal nests in woodlots of variable canopy cover.

prevalent in boreal forest. Species losses did occur in small woodlots in Alberta, however, and more detailed studies are required to determine the mechanisms causing this.

Nest Predation

Nest predation rate was not related to fragment size (Figure 4, R^2=0.36, P=0.83). In a stepwise multiple regression using all vegetative variables measured, only canopy cover significantly explained the variance in nest predation rate (Figure 5, R^2=32.3, P=0.02). Arboreal nests were taken at a higher rate than ground nests (arboreal 35.5%, N=141; ground 6.2%, N=146; G=40.3, P=0.0005). Arboreal nests taken by predators tended to be closer to edges of woodlots, have lower canopy cover, and have a higher diversity of tree species around them when compared to intact nests (Kolmogorov two-sample tests, all $P<0.05$). Avian predators (probably corvids) appeared to take most of the eggs, but some may have been taken by mice or red squirrels.

Results reported here are again different from studies using artificial nests in eastern deciduous forests (Wilcove 1985; Yahner and Scott 1988; Small and Hunter 1988) and from a study in coniferous boreal forest in Sweden

(Andren and Angelstam 1988). All of these studies found that nests in smaller fragments or in more fragmented habitats had higher predation rates than those in continuous forest. In addition, the predation rates after one week of exposure were much higher than at my site: 7% in Alberta and usually over 20% in the other studies on small woodlots. It appears that numbers and probably density of predators in boreal forests are lower in Alberta than in the eastern United States and in agricultural areas in Sweden. Agricultural areas with closely spaced residences may support high densities of generalist predators and domesticated animals such as dogs and cats that may hunt intensively in woodlots.

CONCLUSIONS

As a cautionary note, these results represent one field season and thus should not be used to make generalizations. The study needs to be replicated to see if the patterns hold in more than one year. Territories of birds need to be mapped to determine whether singing males are in fact breeding (Gibbs and Faaborg 1990). Once "area-sensitive" species have been identified, more intensive population studies are required to determine breeding success, habitat requirements and dispersal abilities to determine the mechanisms of species loss in small woodlots (Haila *et al.* 1989). Although nest predation does not appear to be a major negative process in small woodlots in Alberta, cowbird parasitism may be, and this remains to be investigated. Finally, more studies are needed on winter residents and how habitat fragmentation may affect their survival, foraging efficiency, movements, and subsequent breeding success.

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DISCUSSION

Question by Mr. Bortolotti: You were comparing your study to other studies that showed some species to be a little more area sensitive than in your study. Did you find an isolation effect in your study? Were your woodlots on average a lot closer than theirs?

Response by Ms. Hannon: If you look at the literature in bulk from eastern deciduous forests, you often don't get an isolation effect. You will almost always get an area effect.

Comment by Mr. Thompson: With most of these studies, there seems to be an assumption that predation is some constant. Nobody seems to have looked at the predators, predator behaviour, number of predators, and the kind of predation. I would urge you to get at that aspect of it. That may very well explain the difference. There are different predators.

Response by Ms. Hannon: That's right. The number of mammal predators is a lot higher in some eastern agricultural systems. We are dealing mainly with corvid predators in northern Alberta. One of the things we are going to do in the summer is put up some nests with cameras on them, so we can see what exactly is taking the eggs.

Question by Ms. Schmiegelow: It is not clear from the data presented what your actual tests were, or what the effects of fragmentation were. The usual approach is to compare the fragmented area with a same-sized area from a continuous tract and look for a net loss of species over time. You can also compare the parameters of the species and their relationship to slope and intercept. You had two data points from 1 000 hectare areas. You showed a species-area relationship, but whether that is different in your fragments from that of a contiguous area is unclear. Do you have data on that? Do you have sub-samples from your larger areas that you could build a species-area relationship from?

Response by Ms. Hannon: Yes, but I haven't got around to doing that. There is actually quite a bit of data that I haven't analyzed yet. One of the things too that I should do, is look at particular species, where they have occurred within fragments, and try to look at some of the vegetation characteristics. Some of the relationships that I am attributing to area may be related more to habitat.

Comment by Mr. Lakusta: You indicated that woodlot size had a negative relationship with a number of species, but you didn't indicate number of individuals.

Response by Ms. Hannon: Again, those data hasn't been analyzed yet. It is difficult to analyze when you are using point counts. You can't always attribute a singing male to a pair, so you don't know the exact densities. It is difficult unless you get into the intensive work of mapping.

Question by Mr. Savard: When you compare the number of species and area, how do ten small areas compare to your big area?

Response by Ms. Hannon: It doesn't compare because you get characteristic losses of certain species that don't occur in the smallest areas.

Question by Mr. Savard: Is your sample size big enough to test that?

Response by Ms. Hannon: Well, that remains to be seen. I used 15 fragments and that was logistically possible in a field season. I think it was fairly clear that some species dropped out below, for example, 40 hectares. You never found them in a woodlot below that. To look at mechanism, we are going to have to look at individual species, and see what they are doing. I would say by looking at it superficially now, no, you wouldn't. There is obviously some habitat requirement or home-range size that is cutting out some of these species from the smaller woodlots.

Question by Mr. Harris: You didn't point out where your study areas were. How far apart was the large control site from your farmland site?

Response by Ms. Hannon: It was about 25 kilometres away.

Comment by Mr. Harris: My reason for asking is, if you would have crossed the border in Saskatchewan on the west side, there are three species mentioned that are occurring in fragments much less than 40 hectares. Maybe you are outside the range in particular for those three species.

Response by Ms. Hannon: That is possible.

FOREST BIRD RESPONSE TO NATURAL PERTURBATIONS AND SILVICULTURAL PRACTICES: A LANDSCAPE APPROACH TO SUSTAINABLE FORESTRY

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and

Guy Rondeau
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ABSTRACT

An ideal model for sustainable development and conservation of species requires that heterogeneity be preserved in the landscape. A forestry mosaic must be established to include stands of varying composition and age. Stumps and some large trees must be left standing. Comparable elements in the mosaic created must be close enough together to facilitate the exchange of individual organisms and genetic material, which means that it is important to reduce the size of clear-cuts. A very important factor in such a forest mosaic would be the maintenance of a significant proportion of old forests. Though it goes against the grain of standard forest management (that aims to maximize timber production), the presence of old forests is essential to the maintenance of many plant and animal species.

Heterogeneity in forest stands and landscape is the key to conserving genetic and biological diversity and to using animal resources. It is a principle which should protect society against the "artificialization" of our forests, the effect of which is to alter reference standards by undermining public understanding of what a truly natural environment is.

TOWARD INTEGRATED FOREST MANAGEMENT

Nowadays, human penetration of the forest and exploitation of its resources are expanding continually. In terms of forest management, a number of factors have intensified intervention in the forest. Examples are the increasing demand for timber, mechanization of logging operations and extension of the transportation network, to name but a few. Pressure on the forest from recreational activities of all sorts (whether or not involving the taking of game) has also intensified over the same period, and there has been a marked growth in the number of businesses providing services associated with such open-air activities. The forest is part of Canada's heritage and constitutes one of its greatest riches. It must henceforth be viewed as a global entity serving multiple interests.

The evolution of notions of sustainable development, the growth of knowledge of the dynamics of ecosystem components and the newly awakened public environmental awareness make it possible to manage resources better and to make rational use of them through a comprehensive approach. In this context, integrated management is not just a new decision-making process, but also promotes more concrete action on sustainable development. Indeed, by seeking data on both potentially fragile or vulnerable resources, we are better placed to develop scenarios designed to optimize the performance of an area, making better use of all of its components.

In traditional data gathering, the potential of a given resource was evaluated solely in terms of its intended use. Integrated management introduces into harvesting and management concerns the obligation to take into account the characteristics of other resources. Integrated resource management, as applied to forestry, consolidates concern for the characteristics of all components of the environment in order to assess their mutual dependency relations and avoid actions on any one resource likely to damage the others.

Environmentally sound forestry practices

Spatial heterogeneity is clearly the ecological concept underlying any "sustainable" forest management. This principle is the only one that curbs loss of genetic capital in all components of forest ecosystems. The resulting diversity of stand structure and composition promotes biodiversity and, *ipso facto*, the proper functioning of ecological processes whose complex workings are carried out by a host of living organisms (from micro-organisms up to the top of the food chain).

Implementation of the maximum heterogeneity principle in forestry operations implies a complex mix of plant strata within stands and a varied mosaic of habitats across the forest. Given our poor understanding of how forest ecosystems work, a management strategy designed to mimic natural processes as closely as possible seems a valid choice (Titterington *et al.* 1979; DesGranges & Rondeau 1993; Thompson 1993). Selective cutting should be encouraged in hardwood forests with harvesting of small areas and adequate spacing between clear-cuts. Because it favours vertical heterogeneity within stands, it reproduces to some extent the effects of insect epidemics. It would probably be possible to reproduce (at least locally) a landscape comparable to the environmental mosaic left by fire or deadfalls if selective cutting could be combined with group shelterwood felling. In so doing, it would be necessary to ensure that some large trees (especially dying ones) are left standing.

Clear-cutting causes major disturbances in coniferous forests. By radically altering the composition and structure of stands, these habitat changes can be damaging to many animal species as they effect large areas of forest. It is hard to alleviate the negative impact on habitat locally. Consideration ought to be given to a better distribution in time and space of areas targeted for cutting and reducing to a sustainable minimum the dimensions and frequency of harvesting. In the same way, forests that have been destroyed by insects (Thompson 1993) or burned [the cycle is about 75-100 years in the boreal forest (Van Wagner 1978; Telfer 1993)], a given landscape would contain recently harvested sites. Stumps and some large trees would be left standing. The various comparable units of the mosaic thus created should not be too isolated from each other. Keeping cut areas small and distributing them systematically across the landscape should provide an acceptable solution. However, when these areas are allowed to abut each other and accumulate year by year, the principle is undermined.

Heterogeneity as a result of infilling has long been proposed as a natural means of reducing the seriousness of spruce budworm (*Choristoneura fumiferana*) epidemics. By promoting resistant spruce species or those hardwoods that are not affected in fir (*Abies balsamea*) stands, vulnerability to insect infestations can be considerably reduced. There are in fact numerous species of birds that prey on the budworm, insects that parasitize it and pathogens living in pockets of mixed forest within fir stands that attack it (Crawford *et al.* 1983; Maltais *et al.* 1989). It is thought that these species play a preponderant role in regulating endemic budworm populations (Crawford *et al.* 1983). Infilling has great potential from the points of view of both forestry and ecology. It might be applicable to single-species stands whose composition differs sufficiently from the original cover to have an impact on wildlife.

To some extent, insecticide spraying may affect development of the forest mosaic by allowing some old stands to survive in spite of the insect infestation. If they do not pose a toxicity risk for birds, if their action is limited to the targeted insects and if they are used intermittently, insecticides need not cause serious harm to insectivorous birds, most of which can temporarily forage lower in the canopy and in a greater variety of trees to take in insects not affected by the spraying (Hunter & Witham 1985). Those species which are absolutely dependent on insect pests for food can always move to available unprotected stands, the maintenance of which is essential to the forest.

Fire protection is necessary to safeguard forestry resources and investment. Fire often plays an important ecological role by determining the composition of stands covering large areas and by recycling nutrients in burned lands. After clear-cutting, the naturally regenerating growth is often not the same as what would follow a fire in the normal pattern of disturbance. At many sites, fire causes a recrudescence of intolerant species (Spurr & Barnes 1980). It appears the same effects as fire can be created by mechanical scarification or controlled burning. These return nutrients to the humus and promote germination of hardwood pioneer species with fluffy seeds that are carried on the wind to exposed patches of mineral soil (Spurr & Barnes 1980).

An increasingly popular solution for reducing rotation time in harvestable fir stands is clear-cutting with protected regeneration (done in winter using high-riding equipment). This practice is designed to favour conifers and has the effect of shortening the hardwood phase thereby discouraging the flora and fauna associated with it (Durand *et al.* 1988). With this modification in species composition through regeneration protection and fire control, jack pine (*Pinus banksiana*) can be eliminated from an area. Jack pine has serotinous cones that release their seeds during a fire. Black spruce (*Picea mariana*) regenerates well from runners left on site. However, at many sites, especially the most productive ones, fir may form a significant part of the pre-established regeneration. Protection of pre-established regeneration will tend to increase the proportion of fir in the future stands, which might heighten their vulnerability to budworm attack. This management practice favours fir and its associated species, therefore, it must not be too widely applied. The ensuing expansion of fir would be at the expense of spruce forest ecosystems which have their own specific cohort of flora and fauna equally deserving of protection.

Concern for genetic and biological diversity should forestall large scale replanting of the boreal forest. Plantations have little biological diversity (in either flora or fauna), and the genetic diversity of their trees is often low (or very low). This makes them vulnerable to epidemics or disease in the long term. Because forestry operations work on a scale of decades, silviculture is particularly sensitive to problems of this kind. It is better to resort to replanting only at sites dedicated wholly to forestry. Natural regeneration should remain paramount, and research on ways to promote it should be expanded.

Forest management

The effects of forest management differ according to whether extensive or intensive management systems are applied. **Extensive forest management**, the more widely used hitherto, minimizes intervention in the forest and treatment cost per hectare. However, this type of management presupposes a large management area, which effectively cuts down the number of reserves and parks. The maximum area is reserved for timber production to sustain yields. This type of management causes slow but wide-ranging "artificialization" of the environment, with long-term repercussions on ecosystem dynamics and animal and plant diversity.

In contrast, proper **intensive management** can keep costs of timber at maturity to levels equivalent to or below those obtained through extensive management because it has the advantage of preserving stretches of forest where intervention is limited. The resultant scenario is one of zoning, where there are ecological reserves and conservation areas, in which natural processes operate freely. Artificialization is intensive where zones are assigned exclusively to forestry. Such zones are customarily located near mills, thereby reducing transportation costs. However, intensive timber production requires the use of fertilizers and pesticides, whereas extensive management reduces and diffuses their use. The use of these chemicals (being more localized) is subject to better control, and their effects can be alleviated.

Plantations are an intensive forestry practice that may have applications in the future. Plantations provide for future forest yield and supplies for industry. Where the volume at maturity of a plantation exceeds that of natural stands and the cycle is shorter, the effect is to preserve forests. Fewer natural stands have to be harvested to obtain the same volume of timber. Forest managers should not use the increased yield from intensively managed sites to justify an increase yield target for the whole management area.

Whatever system of forestry management is adopted, **conservation** will remain the keystone of any sustainable development concept. It is important to ensure preservation of all the genetic resources of the species that we harvest, those that we do not yet harvest and those that we will never use, especially where they play a major role in the ecosystem. Many boreal forest species have the centre of their distribution within Canada which, because of its northerly position, also has a responsibility for preserving the gene pool of marginal populations of many important species of North American forest flora and fauna.

Conservation of species and of our genetic heritage demands immediate implementation of adequate strategies. Of prime importance is the creation of ecological forest reserves, totalling not less than 12% (as recommended by the World Commission on Environment and Development (W.C.E.D. 1987)) of all ecological regions, wherein species, habitats, and natural processes would be maintained. In parts of these reserves, natural processes eliminated by man, such as fire and insect epidemics might be artificially maintained. Fully protected zones would afford protection against potential mistakes (whether or not we are yet aware of them) in the ways we use forest resources.

ACKNOWLEDGEMENTS

A number of the ideas developed in this article came from a brainstorming session on the forest protection strategy statement recently put forward by the Quebec Forestry Department and in which one of the authors (DesGranges) participated. We are particularly indebted to Daniel Gagnon and Yves Bergeron (two forest ecologists at the Universite du Quebec à Montreal), who also participated in the study session and formulated some of the concepts enunciated in this paper. We would also like to thank Marcel Darveau and Jean-Pierre Savard (Canadian Wildlife Service, Quebec Region), and Tony Diamond (CWS-Saskatoon) for their perspicacious comments upon reading this article.

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DISCUSSION

Question by Mr. Savard: You recommended small cuts be systematically distributed across a landscape. This is contrary to the views of Malcolm Hunter, which tend to put cut blocks closer together and keep a larger area set aside. Could you commend on these different views?

Response by Mr. DesGranges: It is an option I am putting forward, and I realize the one Malcolm is putting forward is also worth looking at. We need suggestions like this and research in these ares to find be the best thing to do in different situations. When you have smaller cut areas, you have more ecotonal zones, and edges. There are several species that live in the edges, so it is good to maintain a good proportion of the landscape in edges. I think both approaches need to be tested in different situations to see which one is the best.

Question by Mr. Bonar: I wanted to explore the idea of extensive versus intensive management. I gathered that you were advocating more intensive management as a means of freeing up some land base so that we can put more into reserves. I agree that is a somewhat laudable objective. In reality, what tends to happen is that the industry regards gains in growth that are obtained through intensive management as additional cut, not a means of maintaining what they already have. There is an institutional mindset that has to be addressed before you can advocate that sort of thing.

Commend by Mr. DesGranges: I agree with you on this. What I was saying is more or less what we are trying to do in Quebec. We are at the stage where several mills are not able to get wood from the surrounding forests. They have to go farther away, and they have started using plantations around the mills. The objective is to develop silviculture practices so that eventually they will be able to grow all the wood they need in the area close to the mills. Foresters in our region believe that they could succeed in using less acreage of forest to get the same amount of wood. I think even though plantations are more artificial than areas which are extensively managed, the differences are not that great. We have some data to show this.

Question by Mr. Fitzsimmons: Would you comment on the effect that fire can have on what forestry would classify as nonproductive habitats? Is there a problem that logging only occurs in commercially valuable stands and not other habitats? Do natural disturbances that occur in these nonproductive stands lead to increased diversity of bird life or other things? Do you see that as a consideration?

Response by Mr. Desgranges: Are you talking about the less accessible stands that are not exploited by the forest industry? Are you asking me whether or not there are natural perturbations in those?

Response by Mr. Fitzsimmons: No, not so much the less accessible stands but the less valuable stands. The forest industry is only going to harvest the stand that has trees of a species and size it can utilize. When a fire goes through, it will also disturb muskeg areas, and shrublands. Under a logging and fire protection scenario, these stands will never be affected.

Response by Mr. DesGranges: I agree with you, but I don't know what has happened to those stands. Fairly recently we started to conduct insect and fire control in the part of the boreal forest exploited in Quebec. It would be interesting to look at those stands that weren't cut because they proved to be less attractive to the forest industry. If an insect epidemic occurs in an are that has been cut a few years ago, I doubt if they will spray that forest. It is quite likely that those stands left over from cutting are subject to insect epidemics.

Comment by Mr. Erskine: In Malcolm Hunter's pictures, cutting half of a block was compared to cutting it in many little bits. If you are going to talk about sustainable use of forestry on a 50-year rotation, then you can't cut more than two percent of it any one year. Otherwise, you are reducing the amount that you can work with. The major problem in the eastern boreal forest is that they are below the level of sustainability. The western boreal forest will undoubtedly reach it before much longer. You referred to having to go to intensive plantations close to mills because there isn't the amount of accessible fibre left in harvestable sizes. Rick Bonar's comment about the industry mindset is right on. The perception is that after all long-term timber leases have been set up, timber is as cheap as waste paper. Obviously you can't recycle sawn timber, but you can recycle paper. This is a mindset that has to be overcome in order to get recycling of paper. It has gotten to a level where a political decision has to be made.

Response by Mr. DesGranges: I fully agree with this comment. Sustainable development is a triad of wildlife, economics, and also a social aspect. We have got to educate people to achieve the preservation of our resources through initiatives like paper recycling so that we can cut down the pressure placed on natural resources.

Question by Mr. Jessup: Ed Telfer talked about 250-year-old black spruce stands surrounding mixed-wood uplands. This is common in Saskatchewan. Fire burns off the high ground, hits a swamp where it is wet, and stops. You need a really hot, intense fire before it will blow out into the swamp. It will only go a short distance before it stops. The 250-year-old black spruce (that we don't want) has been through several fire cycles, but the fire has never got to the swamp. Dr. Hannon talked about not taking bird studies from eastern Canada and using them in the prairie provinces. This is a problem you get with the forest industry in Quebec versus the prairie provinces. Saskatchewan and Manitoba are not rich provinces. The forest industry has been used to construct the infrastructure of roads between the Saskatchewan River and the Churchill River. The local people want roads to their lakes, they want roads to blueberry patches, but they don't want you to utilize their forest. It is their land, and they want that access. We could have a nice little forest around our mill and let the rest of the forests be pristine wilderness for a half a dozen canoeists, but are you sure that the other 975 000 people in our province want that?

Response by Mr. DesGranges: I think we have the same situation in Quebec. I would like to refer to the ideas of Malcolm Hunter concerning optimal zoning of the forest environment. It is not only parks, reserves and intensively used areas that are needed. There are multiple-use areas needed as well that should be maintained in the landscape. This will take into account the needs of the people as far as fishing, hunting, ecological tourism and nature trips are concerned. It is always a matter of compromise. Everybody has clear ideas of what they want, and they are not willing to negotiate. Give me a certain part of the land, and I will accept that you get some land for what you want to do. The best thing to do is to reach a compromise between the different uses of the resources. You make sure that the amount of land devoted to the different vocations is large enough so that you maintain biodiversity, a healthy economy, and the integrity of ecosystems for wildlife.

Comment by Ms. Cumming: I was glad you brought up the point of the 12 percent area to set aside as reserves. I have a comment about the people who want roads into their lake and blueberry patches. Biologists are often accused of being eco-freaks. All we are looking for is a balance between economics, recreation and conservation. We do want some balance in what is going on.

Response by Mr. DesGranges: I think conservation is the priority. If I was to decide between developing better forestry practices or setting aside pieces of land representative of ecosystems, I would say let's do the latter first because you are making sure that you won't lose anything. Then try to develop forestry techniques that are kinder to the environment so you can maintain a better carrying capacity for wildlife.

Comment by Mr. Hunter: I would like to add more comments on the idea of balancing between intensive production and reserves, et cetera. Some colleagues, and silviculturalists have made estimates of what this trade-off would mean in terms of the sub-boreal spruce-wood ecosystems we haven't named. It comes down to three to one. We can get roughly three times the production out of plantation forests than we can out of our current extensive type of management. The way we have projected it is that for every hectare taken out of extensive management and put into intensive management, we can put three hectares into reserves with no net loss of total production. We have been talking no net loss of current production. There are people who will argue that, if we can produce more, we should produce more. We need to generate money for the economy. There are people in the developing world who need a higher standard of living. There is going to be twice as many of them in 20 years, but against that issues of recycling, minimizing of waste and using what we have efficiently; both of those have validity. We find it simplest to say we will maintain our current levels of production.

Response by Mr. DesGranges: Good comment. I don't have anything to say about it.

SESSION 4

FORESTERS' PERSPECTIVES ON INTEGRATED RESOURCE MANAGEMENT; WHERE ARE WE HEADED?

Chair: Diana Boylen
Forestry Canada
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FOREST MANAGEMENT STRATEGIES AND RESEARCH PRIORITIES FOR BIRDS

Ian Thompson
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ABSTRACT

Areas of research that may be worthwhile in answering the question of what is needed to set objectives for biodiversity are illustrated. Methods of measuring and monitoring these objectives are discussed.

The misuse of terminology and the persistence of the myth that clear-cut harvesting is equivalent to fire and other natural disturbances as an agent of change has left resource managers ill-prepared to conserve biodiversity in the face of public demand for sustainable development. Research to gain an understanding of ecosystem assemblage and process is essential if sustainable development is to be practised. Biologists must come to grips with the question of how to address the maintenance of biodiversity within the logistical context of forest product companies.

The ability of the ecosystem to continue to maintain species in perpetuity, rather than the mere presence, absence or abundance of featured species, must be safeguarded. Five areas of forest bird research are proposed.

INTRODUCTION

Forest management is becoming more technical, and increasingly difficult as a result of public demand for sustainable development. That demand has presented resource management agencies with a substantial quandary because they are ill-prepared for their new rôle as agencies for the conservation of biodiversity. Part of the problem relates to re-education of managers to deal with issues that were not taught in university, and are not part of recent management philosophies. Research can help alleviate some of the problems faced by managers, however, the correct questions must be asked rather than focussing efforts in areas remote to priority problems.

MISUSE OF TERMINOLOGY

A common language among resource managers and researchers is a prerequisite to development of programs. Of particular concern is the use of terms that have specific meanings, to mean many things. Wise resource use means that everyone must first understand everyone else. Poor terminology will also result in an unfocused research program.

Some of the common misconceptions among resource managers are to be addressed first. The first is that sustainable development is not multiple use. There are distinct philosophical differences between multiple use and sustainable development of resources. The former views the forests as a collection of services or items which are invariably over-used. The latter sustainable development view considers the forests as an entity or a living system which can be used, but must be maintained. Under multiple use, resources are harvested based on increment in time, and are constrained only by local productivity. Under sustainable development, harvesting is carried out in a manner that does not alter the system.

The constraint is the ability to use the forest without destruction of its integrity.

The second term that is often misused is biodiversity. Biodiversity is not diversity. Biodiversity refers to the variety of life, and their natural combinations. It refers to the structure, composition, and function of genes, species, and ecosystems (Noss 1990). Diversity is a site concept that relates to the number of species and individuals of each of those species in some defined area. Therefore in some cases we may increase the diversity of a site by logging it, but we do little for biodiversity through the action of logging one stand. Certainly we do not speak of the 'biodiversity of birds' associated with a forest type. Depending on your point of view, only god or evolution can alter biodiversity.

Third, old growth in boreal systems is not comparable to old growth as a distinct forest stage in, for example, temperate rainforests. Old growth refers to the steady state mosaic stage in forests where small isolated disturbance is the vector of forest succession. Gap dynamics are important in old growth forests, but not very important in boreal systems, or important for only a short period of time (Kimmins 1987). Boreal forests reach mature and over-mature age classes, but these are relatively short-lived. The boreal forest is catastrophe-driven and within a short period of time will burn or be killed by insects or both.

Fourth, it is a myth to compare current clear-cut silvicultural systems to fire as an equivalent agent of forest renewal. There are substantial differences between the two that result in different patterns of community assemblage.

The differences are:

1) Site disturbance in logging,
2) Removal of all stems from the site in logging,
3) Fire leaves live residual stands, burned trees, and downed woody debris,
4) The frequency distribution of fire sizes and cutblock sizes are different,
5) Alteration of stochastic, competitive, and dispersal processes among plants,
6) Structural differences on the forest floor, and
7) Predictability of clear-cuts compared to unpredictability of fire in distribution and intensity.

I am unaware of any studies, however, that have asked the question of community assemblage after fire and logging.

Fifth, management attempts to maintain wildlife has brought the assumption that if habitat is present, it will be occupied. There are numerous examples of failed attempts at habitat management. There was an early attempt at the creation of spotted owl habitat to allow 100 ha blocks of timber. The stands were sometimes used by the owls, but subsequent predation of spotted owls by great horned and barred owls resulted in non-use. Increased predation and parasitism rates on nests of birds using forest edges have also resulted from improper forest management. The assumption of occupancy is necessary to a certain extent, but a monitoring system and in-depth knowledge of community processes is required.

A final common forest management myth is the implicit (or explicit) assumption that second-growth forest will provide ecosystems similar to those on the landscape prior to logging. Some work being conducted in Newfoundland suggest differences between stand structure, ground cover types, and species composition of herbaceous species between old (60 years) second growth post-logging forest and mature (75 years) natural-origin balsam fir forest. For example, we can discriminate 100 percent of the time between these two types of forest based on percent biotic and abiotic ground covers.

UNDERSTANDING ECOSYSTEMS

We must research and understand ecosystem assemblage and process to sustainably develop forests. In particular, increased examination of post-fire succession should be undertaken. Such studies would improve models for forest development by providing alternatives to current silvicultural practices.

Not all boreal systems are fire-driven. Newfoundland has a unique balsam fir ecosystem. The system is driven by insect infestation, usually either hemlock looper or spruce budworm. Examination of stand sizes destroyed by the hemlock looper (Figure 1) and areas logged (Figure 2) provides an example of the difference between current harvesting practices and natural disturbance). Size is only one variable among many to be examined to understand differences between natural and human disturbance to forests. It is illustrative, however, of the dissimilarity.

REQUIREMENTS OF INDUSTRY TO PLAN HARVESTING PROGRAMS

What is needed to properly plan forest management? Industry requires that there be a continuous supply of timber that is predictable in time and space. For that to become possible, long-term planning is required with a set of clear objectives. Not the least among these objectives are those for biodiversity, and where needed, for featured species. Industry cannot continually be 'nickled and dimed' at the stand level on the biodiversity question. Biologists in the near future must come to grips with the question of how to address the maintenance of biodiversity in order to develop forests in a sustainable manner. Rules for the maintenance of biodiversity must be realistic and workable within the context of logistics of the forest products company. For example, we should not expect helicopter logging in boreal systems.

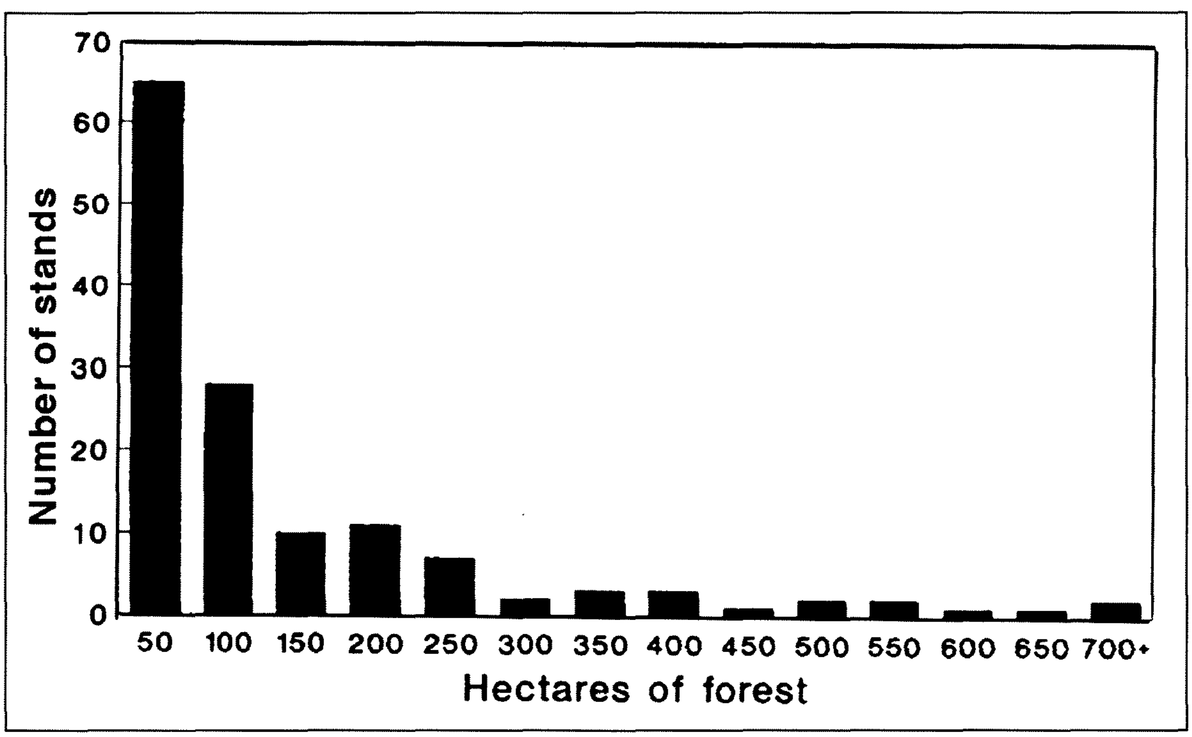

Figure 1. Discrete forest areas destroyed by the hemlock looper in Nfld. - 1987.

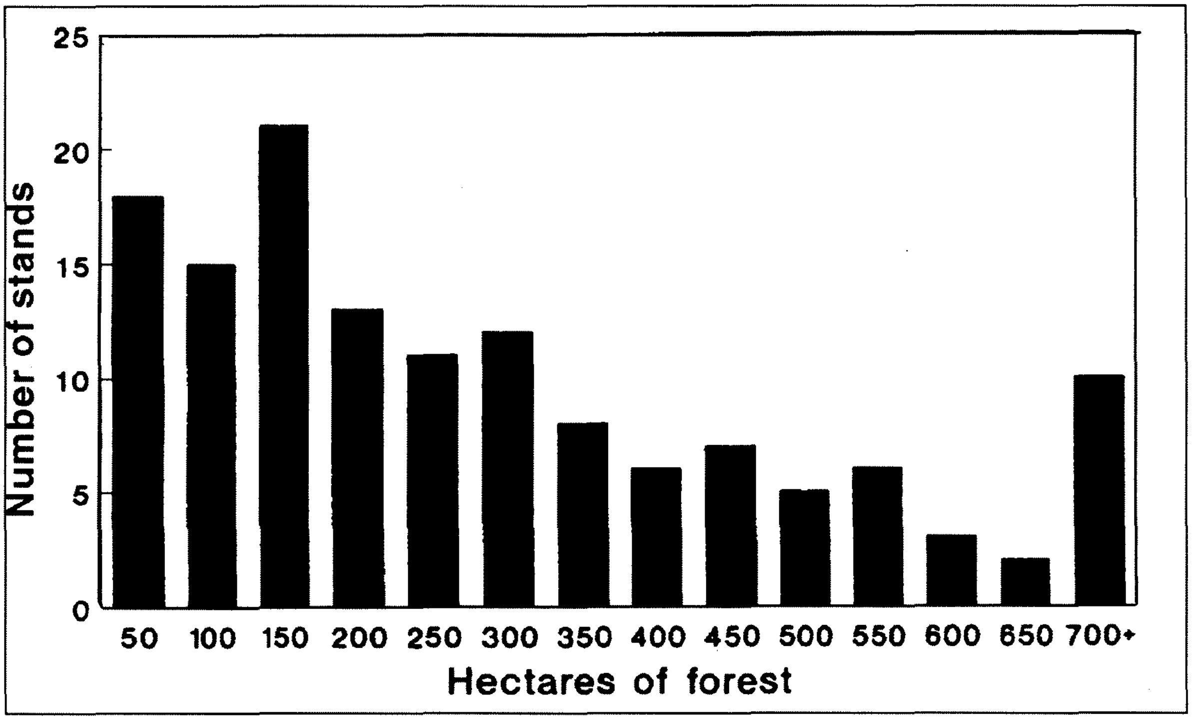

Figure 2. Forest areas clear-cut in two year groups.

There is a clear need for the development of monitoring systems to ascertain whether biodiversity objectives are being met. Monitoring of objectives requires spatial and temporal components because that is how the objectives must be set. Monitoring systems must be relatively simple, but can only be developed once measurable objectives for biodiversity are established. If the objectives are for ecosystem types, then monitoring by remote sensing may be feasible. In the case of objectives for bird communities, for example, a broad-scale series of 10 ha bird plots is not an efficient monitoring system. A monitoring system involving standardized point counts with trained observers is a much more realistic method to use.

There must be a formal mechanism for public input in order to establish credibility of the management system (this has little to do with research). Times have changed, however, and unless the public is consulted in forest planning they will ultimately take the right to manage the forest away from individual companies.

There is a need for a system and protocols to deal with issues such as trade-offs, distribution of species in time and space, and stratification of the land base among uses. Decision support systems require data bases. For example, research into population dynamics of problem species is required in order to develop minimum population modelling.

Finally, all agencies and industry will have to re-tool and upgrade existing systems continually to accommodate technological advances in geographic information systems (GIS) and other models. There is a general need for research into models linking wildlife to the forest, particularly models focussing on predicting density from habitat.

PLANNING PREREQUISITES FOR INTEGRATED RESOURCE MANAGEMENT (IRM)

In order to move to a more integrated and holistic forest management program certain prerequisites must be fulfilled. First, the forest base must be adequately described in a manner that is predictive for timber production and wildlife populations. The format must be hierarchical from stand to landscape, unambiguous (i.e., results will be the same for all users), and the format must predict successional pathways. The research role in this case is to assess the predictive capability of the forest descriptor systems.

Second, within the planning area (e.g., province) there must be a working knowledge of what species occur where. A good example of the kind of information required is a breeding bird atlas such as the one produced for Ontario. Certain wildlife species will drive a planning system for some time in some areas owing to their rarity or the special habitat requirements. For those species, autecology must be well understood to enable practical, effective management. The latter case (rare species) is the only situation for which autecological research should be advocated. Research into limiting factors is an obvious necessity, if a species is rare or declining. Rare species will be a part of all forest management planning. Planners must be aware of whether habitat is limiting or not, prior to developing a management program that ties up land.

Forest inventory could be improved to include variables that are predictive of key wildlife species, where those variables were known, and if a monitoring system is in place. Key wildlife species are those that have been selected to help monitor the maintenance of biodiversity of a system.

A final requirement for IRM to be achieved is the development of cooperative research programs that involve an ecosystematic approach to the problem. Research has taken a scattered approach to addressing biodiversity in Canada. We need to shift to cooperative, coordinated programs to begin to understand function and process in boreal ecosystems.

CURRENT FOREST/WILDLIFE MANAGEMENT METHODS

There are several approaches used to manage for wildlife species within the forest planning system, but none in Canada attempt to deal with biodiversity through objectives. Currently, most agencies are using a featured species approach to forest management. The implicit (if not explicit) assumption is that there is no need to be concerned about other species. The agency believes either those species are not affected by other timber harvesting in the long term, or that managing of featured species will also protect all other species as well. In most cases, the other species have not really been thought about, or the problem is viewed as intractable.

Indicator species, multiple habitat suitability index (HSI), and guild management are in essence advanced or special cases of featured species management. The latter methods tend to involve less generalists and include at least one species for mature forest age class. The major problem with all of these methods is that the more species that are added, the more complex the management plan is, and the more simplistic the individual models must become. The more models (filters) that we force a timber management plan through, the more difficult it will become to meet objectives for either biodiversity or timber production.

Conservation for forest animals cannot be approached using a recipe. Ecosystems differ in structure, function and process, and those aspects must be well understood before a plan is devised. Because of differences, an approach that works well in Newfoundland balsam fir will most likely not work in boreal mixed woods, nor in jack pine. Ecosystem management is a recognition of the diversity among ecosystems, and an attempt to develop methods to sustainably develop each system.

RESEARCH PRIORITIES FOR BOREAL WILDLIFE

This leads to what I believe is the most important research priority in forest/wildlife, "Is the biodiversity associated with post-logging forest the same as would be expected under a natural disturbance regime?" Sustainable development can only occur if we use the forests in a way that leaves biodiversity intact in space and over time.

There are a large number of hypotheses that can be constructed under the guidance of this question relating to species, systems, function, and structure. The question must be answered both at the landscape level and for community structure, and process at the stand level. Collection of data is usually accomplished at a fine scale and extrapolated to the coarser scale of the ecosystem. The mechanism is through the development of predictive models, which must be tested for generality.

The answer to maintaining biodiversity is not in the form of species abundance or presence/absence, but rather in the ability of the ecosystem to continue to function through time, including its ability to maintain a species in perpetuity. If components of the system have been dramatically altered, or are missing entirely as a result of timber harvest, then structure and composition of the ecosystem will have been altered and biodiversity may be lost.

The emphasis of the research program should not be on which species occur where and what habitats they prefer, but rather on the capability of the ecosystem to support avian communities that occur naturally. Therefore the question, "What is the bird community of a 20-year-old post-logging and how does it differ from a 200-year-old stand?" is interesting. It is not as valuable as the comparison to a 20-year-old post-fire stand on a similar site. There are a large number of questions and hypotheses that can be framed in the context of community structure of second forests, including those pertaining to how the forest can be used in a sustainable manner.

In our Newfoundland research, the same stands used to study forest structure are also being used to examine mammal, bird, and insect communities. The bird study is being conducted in cooperation with Holly Hogan and Bill Montevecchi at Memorial University. The first year data are insufficiently analyzed and require a second year to be fully meaningful. There are some early patterns emerging for birds. Some species, notably grey-cheeked thrushes, black-backed woodpeckers, and red crossbills are only found in forest stands of natural origin. In addition, there are species differences between the natural and second-growth forest bird communities. The data show that community structure has changed, although further change may yet occur over the 10-year period that our types differ in age. If there are significant differences between community structures, does this matter? After all, with the possible exception of rare species, all of the parts are there. Such changes may be significant because of the alteration of process, structure, and function within the ecosystem.

CONCLUSION

Throughout this paper, I have tried to illustrate areas of research that will be fruitful in terms of dealing with the following questions: What is needed to set objectives for biodiversity? How do we measure and monitor objectives? What form should research questions take for forested systems? In summary, the following is proposed as five areas of forest bird research.

The importance of cooperative research in how systems function is emphasized as the necessary pathway to holistic forest management.

1) To understand alterations to bird community structure attributable to forest management, particularly at the landscape level.

2) To understand factors limiting rare or declining species.

3) To develop predictive models of community structure and populations.

4) To develop monitoring systems for biodiversity objectives.

5) To develop techniques to improve forest management to maintain biodiversity in time and space.

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DISCUSSION

Question by Mr. Savard: Can you elaborate about what type of monitoring system you foresee or would like to see?

Response by Mr. Thompson: The monitoring system has to be geared to the objective. It is difficult to foresee what it might be. It has to be relatively rapid, for example, 10-hectare bird plots are probably out in terms of monitoring forest bird communities through time. I am not suggesting that that ought not to be the kind of thing that we do, but we need a much more rapid method of collecting the information. Similarly, when collecting data on forests, I think that there is a good opportunity to develop information meaningful to wildlife that can be collected at the same time when people are using forests to determine age structure of forests. I don't really know the answer. It depends very much on the biodiversity objectives that people set, the kinds of systems that they end up settling on.

Question by Mr. Hunter: Your suggestion that grey-cheeked thrushes, black-backed woodpeckers and red crossbills might be absent from post-harvesting stands is potentially very disturbing. How confident are you of that?

Response by Mr. Thompson: I am not because it could easily be a function of sampling. It is not a function of sample size so much as it is the density of those species. They are what you would call commonly rare species, especially in the case of crossbills. One year you get thousands of them; the next year you have two, so it is very difficult to get a handle on that.

Question by Mr. Hunter: How many stands were sampled?

Response by Mr. Hunter: In the case of mature and over-mature stands, 14 or 15 stands; in the case of second-growth stands, 20 or 30 stands. We have tried to standardize all of these for site type and so on. This has set off some bells and whistles in our heads about what is going on. I think we are probably going to try and design a sampling technique that will try and deal more effectively with some of these rarer species. You are right; it is very disturbing.

Comment by Mr. Sequin: In your chart, you showed an increased amount of shrub development in the second-growth forest.

Response by Mr. Thompson: Yes. Understand that this is a balsam fir ecosystem, so there is balsam fir here and there.

Question by Mr. Sequin: I am not worried about species composition, but of the three species (the birds you said were absent), is that not analogous to the B.C. situation where they are feeling that the barred owl is eliminating the spotted owl because of the shrub development?

Response by Mr. Thompson: My understanding of the situation between the barred and spotted owls is that there is a direct predation of barred owls on spotted owls.

Comment by Mr. Sequin: Yes, the advantage in feeding is that the barred owl is more adapted to the shrub.

Response by Mr. Thompson: It is quite possible that this is a habitat effect.

Question by Mr. Farr: You talked about processes and the importance of understanding ecosystem processes, and you identified differences in the bird communities between the two. You also suggested that there are possible process explanations for those differences that you observed. I wonder if you could speculate as to what kinds of processes those might be, and also speculate on what kinds of research approaches would be the most profitable to identify what those processes are?

Response by Mr. Thompson: I wouldn't want to speculate on what processes are, but I would certainly suggest an avenue of attack. I think in this country a much more coordinated approach is needed in ecosystem study, for example, the model of what was done in the Pacific Northwest of the United States. A large number of people attacked the same ecosystem at the same time and used different data bases. I think that is the kind of thing that we need. In terms of trying to monitor the processes that are going on, I would suggest that we need much more physiological research into stands. In other words, trying to understand the physiological processes that are going on within the stands, because I think that those reflect the productivity of the stand, and ultimately will reflect in differences among stands, and differences among managed and unmanaged stands.

Comment by Mr. Farr: I wanted to reinforce the importance of understanding pattern as well so that we can at least have a basis of understanding the ecosystem that we are dealing with.

Response by Mr. Thompson: I don't disagree with understanding pattern at all. I think that if we are focusing our efforts on trying to develop a management system that closely mimics natural processes, then we want to try and focus on what the differences are. I think that is a very good direction to go. I think there is a tremendous opportunity now, to try and marry forest ecological classification with some of these physiological remote-sensitive models that are being developed. I think that that is an excellent direction to go. It deals with the FEC's problems after logging and the successional direction that they might go. The physiological approach to the problem might be an alternate attack at the same problem.

FOREST MANAGEMENT AT WEYERHAEUSER IN SASKATCHEWAN: PAST, PRESENT AND FUTURE

Jack Spencer
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ABSTRACT

The paper first discusses changes in corporate forest management practices over the course of time in an area of central Saskatchewan. An integrated forestry and wildlife management project that the current licensee is involved in is outlined in the second half of the paper.

The major changes in forest management include a move away from selective logging for coniferous species by hand falling to clear-cut harvesting of mixedwood stands using mechanical harvesters. Success rates of spruce plantations were improved through the increased use of site preparation and mechanical cleaning. The chief developments under the current licensee include the increased use of aspen for pulpwood furnish and the acceptance of a policy respecting other uses of the forest.

The integrated forestry and wildlife project has five major objectives: the development of quantitative tools such as habitat suitability indexes; operational guidelines for forest planners; spatially related objectives for wildlife habitat; economic cost assessment models; and a communications programme.

The project is currently developing timber supply models that concurrently take into account the supply of wildlife habitat to arrive at an annual allowable cut. The supply of wildlife habitat is based on five indicator species: moose, caribou, beaver, snowshoe hare, and pileated woodpecker. Five other government and non-government agencies participate in the project.

This paper takes its perspective from the fact that many people are not familiar with the forest management program in Saskatchewan. The objective is to provide an idea of where the program has been, where it is now, and where it is going in the future.

Weyerhaeuser's forest management licence agreement area is an area of about five million hectares in the middle of the province (Figure 1). This is the licence area that Weyerhaeuser has been managing since 1986, however, the history of this area goes back quite a bit further.

Prior to Weyerhaeuser, the western part of this licence area was managed by Saskatchewan Forest Products, a Crown corporation, supplying wood to a 40 million board feet a year sawmill in Big River. The eastern side of this licence area was managed by Prince Albert Pulp Company for what was initially a softwood kraft pulpmill. Before 1986, these two mills operated more or less independently. Prince Albert Pulp Company purchased softwood chips from the Big River sawmill operation, but the hardwood in this area was essentially unused.

The western part of the licence area is primarily aspen and mixedwood forest cover types. The central and eastern area contains more pure jack pine, black spruce, jack pine and black spruce complexes, although it does have a mixedwood component as well.

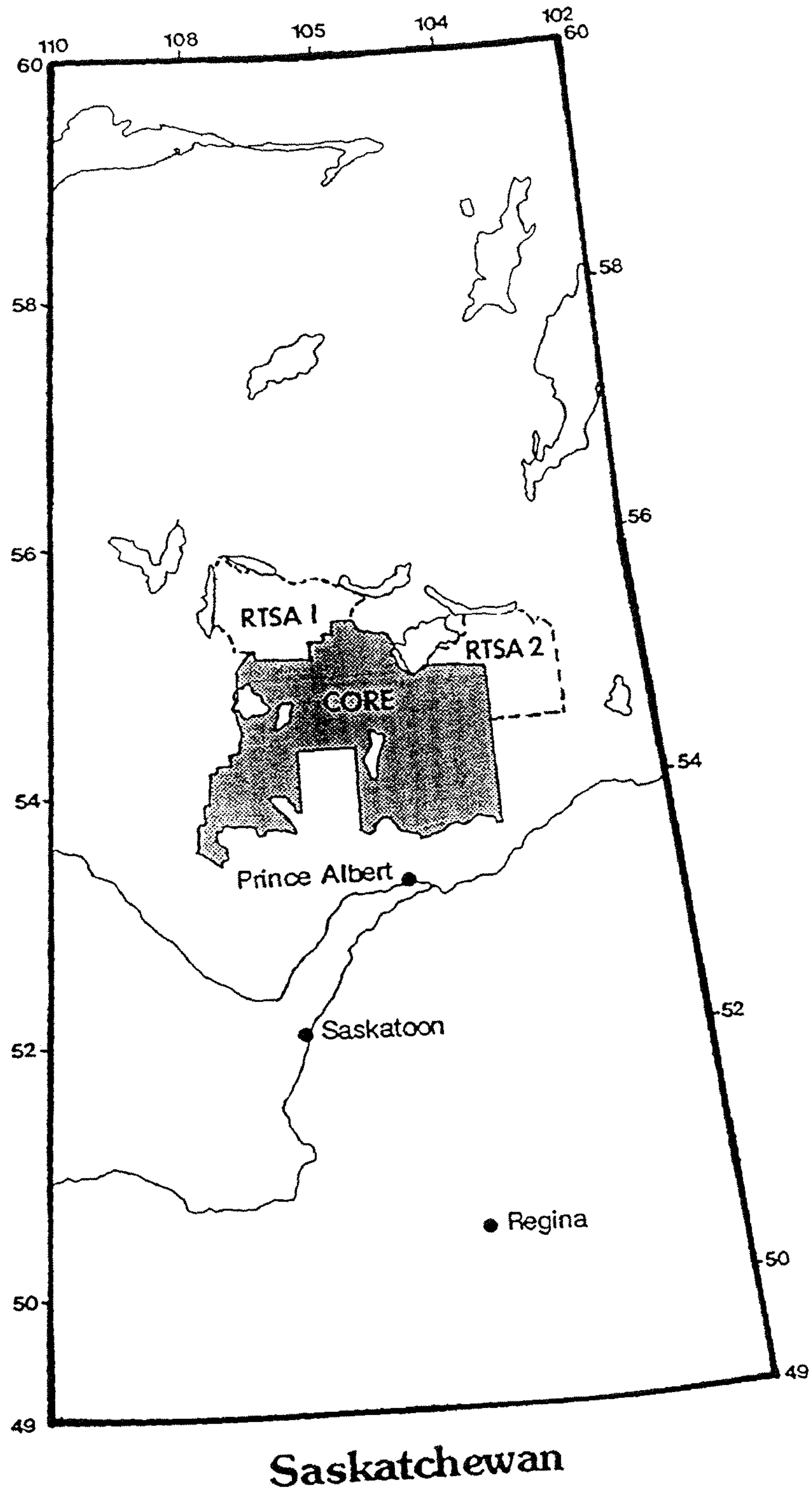

Figure 1. Weyerhaeuser Canada Ltd.'s Saskatchewan Division Forest Management Licence Agreement Area (RTSA = Reserve Timber Supply Area).

Logging in the Big River area has a long history, going back to the turn of the century. Since that time there has been a sawmill of some sort in the Big River area. Old spruce and aspen complexes have supplied the raw material to those sawmills over time.

Until recent times, the method of harvest was to cut the sawlogs and leave the pulplogs (i.e., selective logging). These types of operations in the Big River area have resulted in a changed forest ecosystem; one that now has a predominance of balsam fir. This may be part of the reason why there is a spruce budworm problem currently being faced in the Big River area.

The Prince Albert pulpmill started harvesting in 1967. Logging was directed primarily at the black spruce and jack pine ecosystems that are predominant in the central part of Saskatchewan. Logging systems were primarily chain saw and skidder. There were some attempts made in the mid-1970s to move to a mechanical-type logging system. Those faded away, proving to be uneconomical. The technology was not quite ready. The chainsaw and the skidder were therefore the primary tools for getting the wood off the stump and onto the landing for the first 20 years of the pulpmill's operation.

During the 1970s and the 1980s, the company operated four, 100-man camps in northern Saskatchewan. The workers would leave home late Sunday night, go to work Monday and stay until Friday. The amenities of home were there, but the men were away from home. The size of the work force and the distances that the wood was hauled in those days necessitated these large camps.

Reforestation efforts of the Prince Albert Pulp Company began in about 1970. Reforestation efforts on the Big River side were not extensive and consisted mostly of planting white spruce on partially logged sites. These early efforts at reforestation by softwood planting were in many cases marginally successful. The reasons for that limited success include the residual aspen that was left in these mixedwood cutovers. The young hardwoods sprang up quickly and soon overtopped the white spruce seedlings, choked them or slowed down their growth and development. Competition from grasses and herbs, and the competition for moisture and nutrients also contributed to the lack of success. Part of the problem was a lack of site preparation (trying to put the trees into the ground without any site disturbance). Around 1980, the company started to site-prepare areas where trees were being planted. This significantly increased the success rate.

Tree planting is just one of the methods used use for regeneration. Regeneration stimulated from natural seed sources has been more successful. Some cases have been too successful, with overstocked stands of jack pine coming back. During the early 1980s, a program was started of manually thinning overstocked jack pine stands with brush saws to provide the extra space that the trees needed to grow and develop.

Today, we also "clean" some spruce plantations. This means removing the aspen sprouts that have come up around the spruce using brush saws as well. Herbicides are not used to release conifer species in Saskatchewan.

A lot of the systems that were used in the 1970s and in the 1980s are still being used. New and better ways to re-establish the forests are being continually looked for.

One method that has been used for a long time is the ship's anchor chain drag for jack pine and black spruce natural regeneration. It knocks down the slash, exposes the mineral soils, and spreads the cones out on the ground to promote seed dispersal.

Another tool used extensively is a V-plow mounted on a caterpillar tractor. It clears or scalps the duff and debris off an area. This is used in conjunction with planting of both jack pine and white spruce.

Another machine that has been used for a while is called the Bracke cultivator, which is drawn behind a skidder. The steel wheels turn at a different rate than the skidder, thereby creating scalps that can be planted. This piece of equipment can also facilitate natural seeding, if there is a seed source of jack pine or black spruce.

A more recently used tool is the power disc trencher mounted on a skidder. Steel discs on the back scalp the ground exposing the mineral soil, and distributing the cones. This can also be used as a site preparation tool for planting.

Another piece of equipment used is called the drum chopper. It consists of heavy barrels filled with fluid and with grader blades mounted on them. It essentially chops up the debris on the site when drawn behind a tracked prime mover. Good applications for this piece of equipment are in old mistletoe-infected stands where there are a lot of standing dead or diseased trees that need to be cleaned up to prepare the site for planting.

Weyerhaeuser came to Saskatchewan in 1986. The company assumed the ownership of the kraft pulpmill in Prince Albert that uses both hardwood and softwood trees to make pulp. Experimenting with aspen for making pulp started in 1983. Production has continued to date. Roughly 35 percent of the pulp produced is aspen pulp. A paper mill was constructed in 1988.

Weyerhaeuser acquired the sawmill in Big River in 1986. At that time a 35-40 million board feet per year random length sawmill that primarily used white spruce was constructed. It has been upgraded to a 90 million board feet per year facility.

Along with these mills also came the rights and the responsibilities of a Forest Management Licence Agreement. Sixty percent of the wood for these two mills comes from this Forest Management Licence Agreement area. The rest of the wood supply is purchased wood from mills at Meadow Lake, Hudson Bay and Carrot River. Wood is also purchased from independent operators harvesting on private land.

The five-year average cutover is 5 800 ha per year. That area generates roughly 1.2 million m^3 of wood annually. Some responsibilities come along with the rights to the timber. Primary among the responsibilities identified in the Forest Management Licence Agreement is the maintenance of the long-run sustained yield of the timber. This is a guarantee that there will always be as much timber on the Licence area as there was when operations started. This is the essence of the Agreement. The forest management activities identified are directed towards achieving that objective.

Logging methods over the last five years have moved towards mechanical systems. Eighty to 90 percent of the wood that is produced on the Licence area is harvested by mechanical means. This includes the harvesting, forwarding and delimbing of trees done primarily at roadside. The trees are skidded to the landings with limbs attached, and are delimbed on the landing. This has not been without problems, and solutions are being implemented to those problems.

The types of stands that are logged today are different than the ones that were logged even five or ten years ago. Jack pine and black spruce were logged primarily. The amount of mixedwood stands that is harvested today is much more significant. The mixedwood stands represent about 50 percent of the annual cutover. In excess of 80 percent of the harvest is coming from spruce and aspen stands with the pure white spruce stands and the pure aspen stands included.

Sawlogs are sorted on both the Big River and the Prince Albert side of the Licence area.

Some logs are hauled in excess of 150 miles from the Big River sawmill. Three products are generated out of most cutovers. Clear-cutting all stands has been done for the last two years. This has generated hardwood pulp, softwood pulp, and sawlogs from the same site.

In general terms, the reforestation prescription is to regenerate stands back to their original species makeup. If a stand was pure softwood or softwood predominant, the management strategy would be to get those back to a primarily softwood component. If they were pure hardwood or predominantly hardwood, the management prescription would be to bring those stands back to a hardwood component. As a reflection of the type of stands that are now being harvested (i.e., mixedwood spruce and aspen stands), between five and six million trees per year are being planted. This is a three-fold increase from four years ago. The feelings are that to get them re-established, site preparation would have to be conducted before planting. Conversely, fewer jack pine and black spruce sites are scarified for natural regeneration. Pure aspen stands sucker back on their own, and there is little, if any, reforestation activity required on them.

Something else has changed in the business over the last five years aside from the logging and the reforestation activities. Essentially for the first 20 years of existence, Weyerhaeuser was a fibre products company. The responsibility for the other resource interests were delegated, defaulted, or assumed by the province. Included in the Forest Management Licence Agreement is a reference to the other users of the forest. Although it may be a small clause, this clause has been taken quite seriously by the company over the last five years. The President and Chief Executive Officer, Mr. McInnis, has clearly sent the message throughout the company that the activities will be able to continue on public lands only through continued public support.

There is an active program of consultation with other stakeholders, cottage owners and trappers. As well, public meetings are hosted annually to review the annual operating plan and silviculture plans. It is a two-way communication of our advising the public what has been planned for the next year and the public providing feedback. That feedback may include specific concerns regarding their cabin or their trap line. Or it may be of general nature reflecting public concerns over the state of forest management on our licence area. Contact is maintained with some of the other groups in the province such as the Saskatchewan Wildlife Federation and Saskatchewan Trappers Association. These activities in themselves represent a major departure from how forest management activities have been conducted in the past.

This discussion will now focus specifically on an integrated forestry-wildlife project; the Saskatchewan Forest Habitat Project that Weyerhaeuser is cooperating in. In 1986, Terrestrial and Aquatic Environmental Managers (TAEM) were contracted to produce a report that focused on successional trends after logging with respect to wildlife. A natural follow-up to that project was a more all-encompassing study that would identify ways that the company could integrate wildlife management with the forest management program. Weyerhaeuser, the Saskatchewan Parks and Renewable Resources Wildlife Branch, the Saskatchewan Wildlife Federation and Wildlife Habitat Canada, with the assistance of Bob Stewart and TAEM, formed a partnership known as the Saskatchewan Forest Habitat Project. This five-year project officially got under way in October 1989.

Five primary objectives for this project have been identified. The first one is to develop tools to allow the integration of forest and wildlife management to occur. The kinds of tools are habitat suitability indexes for indicator species, successional models, timber/wildlife habitat supply models, and geographic information systems.

The second objective of the project was to establish spatially-related objectives for wildlife habitat and for forest products. The belief is that one cannot have everything, everywhere, all the time. Priorities have to be set; priorities that do not totally exclude any other resource interest. There is a need know where the province's priority is to manage for moose, and where it is important to be managing for woodpeckers, or both.

A third objective of the project is to produce guidelines to allow forest planners to achieve the objectives operationally. How should the cutovers be laid out? Should they be 120 hectare cutovers? Should they be smaller or larger? Does it depend on the species? What is the critical distance for a moose to cover? What is the critical distance for riparian habitat? What are some of the guidelines to use with an aerial photograph and a map, and attempt to draw up an operating area?

Fourthly, development of some economic models to assess the cost of integrated management is needed. "Economic" does not mean that all decisions would be based strictly on economic value. However, unless the impacts of alternative management strategies on the business are known, it is hard to make decisions without having a bottom line number on what it costs to do these things. An economic component is an integral part of the project.

The last objective of the project is to communicate what is being done to both our internal and our external audiences. As far as progress towards the objectives, six habitat indicator species to date have been selected. They are moose, caribou, beaver, snowshoe hare, pileated woodpecker, and ovenbird. The intent for each of these was to represent either a definitive successional stage or an ecosystem or some other important niche in the forest ecosystem that could be impacted by the operations.

The first indicator species, moose, is identified as having economic and recreational importance to the people of Saskatchewan. This species has prompted the Saskatchewan Wildlife Federation to become interested in the project. Moose live in a variety of mixedwood stands of different ages.

The caribou is socially and culturally important. This species seems to be of significance to a lot of researchers across Canada. It is generally found in jack pine and black spruce stands that have the food and shelter it requires. The third indicator species is the beaver, of social as well as economic importance. It is representative of the riparian areas on the licence area.

The snowshoe hare has an economic impact. They feed on young regeneration, stripping the bark and killing the trees. There are some spruce and pine plantations that have been totally wiped out; a significant investment lost because of the snowshoe hare.

The fourth indicator species is a pileated woodpecker, representative of the later stages of spruce and aspen mixedwood.

Finally, the ovenbird is a neotropical migrant representative of medium age aspen and mixedwood stands.

The accomplishment so far includes the development of habitat suitability indices for these species. These identify what key elements contribute to the quality of habitat for each species and allow the measurement of what the impacts of our activities may be. Existing U.S. Forest Service models were modified for local conditions based on field work which has been carried out to refine and support these models.

Weyerhaeuser is currently in the process of selecting "timber supply" models, which in essence will be timber and wildlife supply models. They will identify what the allowable cut of the timber is, and what the long-term habitat outlook is. The models that were used for timber supply analysis in the past were geared towards maximizing timber production.

Incorporating other values will not be without cost to the industry, and as mentioned, there will be an economic component. The amount of timber that can be harvested will be reduced and costs will be increased.

We are in the process of developing successional models to support the supply models that will predict what the structure of the stands will be over time following disturbance. The original makeup of a forest stand as well as the intensity of management after harvesting will dictate to some degree what that stand will look like 5, 10 or 30 years later up to maturity at 80 years or more. The development of wildlife objectives for a pilot area is also to be done this year.

Since 1989, new partners have been brought into the project; Prince Albert National Park, Forestry Canada under the auspices of the Canada-Saskatchewan Partnership Agreement in Forestry, and most recently, the Federation of Saskatchewan Indian Nations. When complete in 1994, the hope is to be in a position to implement the findings from this project into all of the forest management plans on the licence area.

Forest management practices are carried out differently than five years ago. The same is true for the industry all across Canada. It is safe to say that things are continuing to change. The public is sending very clear messages. Although they want the economic benefits of the forest industry, they do not want it at all costs. Finding ways to allow a viable industry to exist by integrating management practices to insure the integrity of all of the resources that people want sustained must be continued.

PRESENTER'S NOTE

This presentation was accompanied by about 60 slides. The lack of these slides detracts from this discussion. The original presentation was intended to be an informal one referring to the slides. This documentation was prepared from notes and transcripts after the workshop.

DISCUSSION

Question by Mr. Bortolotti: You are in a difficult position because there are so many forest users with special interests. When you have conflicts of interest, some of your practices are going to benefit moose, and they are going to be deleterious to caribou. Perhaps the optimal practice for songbirds is different from moose. Do you have any sort of organized way of priorizing the needs of these groups, or do you look at it on a case-by-case, day-by-day basis? Who has got the most political clout? How do you approach trying to solve problems of conflicts of interest?

Response by Mr. Spencer: I suggested earlier that you can't have everything, everywhere, all the time, and undoubtedly somebody will not be happy with decisions, but if you don't make decisions, if you don't set priorities, we are going to be in the same place five, ten years from now. What we see happening is the other users, and right now I see that primarily through Parks and Renewable Resources, the need to identify their priorities for wildlife management, what types of ecosystems, what geographic areas do they want to set a priority on for moose habitat, for moose management?

Some of those are going to be exclusive of other resources. Some, I suspect, are not going to conflict at all, but it is going to be up to the people who want to manage for the other resources to set the priorities.

It is also up to us to determine what our priorities are with respect to timber. Do we need to always get every stick of wood off of every area? I suggest not. We may wish to in some areas. We may mutually agree that this will be a prime timber production area and that timber takes precedence in some areas. That doesn't mean that wildlife considerations will be totally overridden, because we may be able to continue in the way that we would like to continue our forest operations in an area, if it is intensively managed, and still facilitate wildlife.

Question by Mr. Bortolotti: So you are looking to the provincial government for a lot of the direction for the priorizing of needs?

Response by Mr. Spencer: We are still a timber company. What we have said is we recognize the need to integrate other resources. We are willing to cooperate, but I am not a biologist. Somebody has to tell me what the operational guidelines are. When we know the objectives for wildlife, then we can sit down and make plans.

Question by Mr. James: I have got two questions, Jack. First of all, how are you going to be evaluating the success of the habitat suitability models, and secondly, what plans does Weyerhaeuser have for snag retention on sites? Are we only going to be leaving snags on sites that are identified as being good habitat for pileated woodpeckers and removing snags in other places, or what is the situation?

Response by Mr. Spencer: As far as evaluating the models is concerned, I don't have a quick answer for that. I noted that in a previous speaker's discussion. I guess what we are doing to try to do right now is take what we have got, what we think is best and get it in place. Monitoring of anything like this is essential, and I can't say that I am aware of a strategy in place to monitor this over the long term. It is going to be a while before that is ready to be monitored. You might want to talk to Bob Stewart, our consulting biologist on this project, as to what his thoughts are as to monitoring in the future. I guess I have to say our priority right now is to get out there and do something different than what we have been doing.

As far as the snags are concerned, that is a good question. I guess on one hand I am waiting for somebody to confirm where and when snags are important. It is certainly something that we could incorporate into our harvesting plans in some areas. We have a group in Saskatchewan known as Occupational Health and Safety, and we have to cross that bridge first. Legislated safety guidelines were in place from the days when there were chainsaw operators and there was risk to those people. That is not to say that the risk is totally eliminated; as I pointed out, we are a lot more mechanized. I think there probably is an opportunity to leave snags. We have to make sure we are clear with Occupational Health and Safety. It is another one of those guidelines that we have to understand where it is important. If an area has been designated as prime woodpecker management, is that where we should be considering leaving snags? Should we just be considering leaving dead ones or should we also be leaving a certain number of live trees on the site for that purpose?

Question by Mr. Fitzsimmons: I would like to ask what the long-term outlook is for white spruce sawlogs in your lease area. I note in your discussion that the capacity of the Big River sawmill has been doubled, and you are focusing about 50 percent of your cut now on mixedwood. I think a lot of the discussion in the last day and a half has focused on upland mixedwood sites rather than black spruce and jack pine sites.I think there is probably going to be a real correlation between habitat for a lot of the species that use the older upland mixedwood forests, and the white spruce sawlogs that your mill uses. I am wondering what the outlook is for this area over 50, 75, 100 years.

Response by Mr. Spencer: I would say that over the longer term, based on the last simulation that we did of the timber supply model, we saw a declining composition of spruce and spruce mixedwood stands on the licence area. As far as what the supply of sawlogs is, the question I can throw back is, what constitutes a sawlog? That is technology, but the type of stands we are using right now that we call the mature, the overmature spruce and aspen mixedwood, we feel that we have a 30-year supply of those types of stands in mature growth types in the Big River vicinity right now.

We are also, as I mentioned, bringing logs from the Prince Albert site over there to supplement the Big River sawmill. In the last couple of years, about a quarter to a third of the wood supply for the Big River sawmill come from non-divisional sources.

Question from Mr. Harris: With your increased use of aspen, you were talking about utilizing the mixedwood stand to a greater degree. The clear-cutting of those stands and the postharvest management of those would be for the HS (**H**ardwood-**S**oftwood) stands to be managed for aspen and the SH (**S**oftwood-**H**ardwood) to go to spruce.

I envisage that pure aspen is what will likely come back from an HS, and pure white spruce or whatever softwood species you choose will come back from an SH. Does this mean that the true mixedwood as I see it, which is the trees mixed together in one stand, is going to disappear from the Weyerhaeuser lease area? What are your plans to maintain the mixed stand rather than the pure stand side by side?

Response by Mr. Spencer: What I see happening is the H (Hardwood) stands coming back to H, the HS coming back to pure H, unless there is natural seeding into those stands forming a spruce component underneath.

The SH stands we site prepare, plant spruce, and mechanically clean once will likely have cost us well over $1 000 a hectare to get spruce back into that stand. Even with that, what I believe those stands will be is a mixedwood stand, so maybe the question is, Will there be any pure white spruce stands out there? I believe that those S (Softwood) and SH stands are more likely to be our mixedwood stands. When you are limited to mechanical cleaning, you are looking at a very expensive proposition to try to maintain these spruce plantations as a pure spruce stand. We are looking at alternatives, partly because of the cost, partly by the results.

Again, what some of these alternatives will mean is less production of the desired species. When I am talking about alternatives, I am talking about maybe strip cuts for natural regeneration, try to encourage the natural regeneration to come in, but delays the rotation period that we have established and therefore the productivity. Have I answered the question?

Response by Mr. Harris: I guess so, in a way. You still don't give me the impression that your company is trying to promote a mixedwood forest. I agree that that may actually occur, but what I see happening is the HS is going to revert back to pure H in all likelihood. There is less chance of white spruce seeding into those stands on its own. The next time around, I see a gradual progression to a greater component of H and a lesser component of S in your current SH stands. I see a gradual fading of mixedwood stands.

Response by Mr. Spencer: I think it is probably an accurate assessment, Wayne, based on our current strategy. We are not deliberately managing for mixedwood. It is kind of by default.

A FORESTER'S CHANGING PERSPECTIVE ON INTEGRATED RESOURCE MANAGEMENT IN BOREAL MIXEDWOOD ECOSYSTEMS

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ABSTRACT

The major developments of forest management in the boreal mixedwood forests of western Canada are chronicled in two parts. The first part covers the period 1900 to 1955. Federal and provincial legislation, efforts in growth and yield research and harvesting methods are discussed. Problems with coniferous reforestation on mixedwood sites were already clearly recognized in this period.

The second part covers the period from 1955 to 1992. Increased mechanization leads to the use of clear-cutting as the dominant method of harvesting, and introduces a host of environmental problems. The increasing conflict between developmental, environmental, and social justice issues are reviewed. Societal demands for sustainable development are in concert with global awareness of ecosystem limitations. Aboriginal peoples and women in the environmental movement figure prominently in societal demands. The growth of the commercial importance of aspen brings new impetus to mixedwood management.

A point form comparison of the author's views on resource management in 1955 and 1992 is presented. The greater complexities posed by the need for integrated resource management in 1992 are clearly evident. A chief development is the move away from stand level management towards ecosystem or landscape management. Another major change in perspective is the recognition of the role of old growth forests in ecosystem diversity.

INTRODUCTION

In the interests of facilitating professional interaction, this paper will provide non-foresters with a profile of the mixedwood forester in historical context. This will be done by briefly reviewing the evolution of boreal mixedwood forest management, from its roots in inventory and fire protection in a period of abundant resources, limited utilization, low-tech timber harvesting and classical European silviculture, to the complex social and technological issues of today. Included, will be: increased utilization, conflicting resource demands, high-tech inventory, planning, harvesting, and monitoring, and global concerns.

THE BOREAL MIXEDWOODS

The extent and nature of regional boreal mixedwoods is shown in Figure 1, which includes the Manitoba Lowland Section, the Boreal Mixedwood Section, the Lower Foothills Section, and the Upper Liard Section (Rowe, 1972). They occupy about 150 000 sq km, one-third of the productive forest land in the prairie provinces, and represent some of the most productive forest sites for timber in the region (Corns and Annas 1986; Kabzems *et al.* 1986). They are well located with respect to transportation systems, communities, and power. They have historically been exploited primarily for coniferous species, especially white spruce

Figure 1. The boreal forest in the prairie provinces: sections B.15 (Manitoba Lowlands), B.18a (Mixedwood), and B.19a (Lower Foothills of the Boreal Forest Region (Rowe 1972).

(*Picea glauca* [Moench] Voss), jack pine (*Pinus banksiana* Lamb.), lodgepole pine (*Pinus contorta* var. *latifolia*) and black spruce (*Picea mariana* [Mill.]B.S.P.). Until recently there has been little market opportunity for species like aspen (*Populus tremuloides* Michx.) and poplar (*Populus balsamifera* L.).

THE EVOLUTION OF FOREST MANAGEMENT IN BOREAL MIXEDWOODS

A Regional and National Context - 1900 to 1955

The first timber inventories and scientific studies of growth, and yield in Canada began during the period 1900 to 1910. Management and protection of forests in the prairie provinces were a federal responsibility under the Forestry Branch of 1899 (Bickerstaff and Hostikka 1977). Working plan surveys, forest management operations and fire protection continued under federal jurisdiction until the National Resources Transfer Act (1930) when these functions reverted to the western provinces. The transfer included all federal forest reserves, initially established under the Dominion Forest Reserves Act of 1906.

Early foresters were mainly Europeans and Americans with training in the European tradition of intensive forest management. Their valiant attempts to establish classical silvicultural systems in the previously unmanaged forests of western Canada are still evident in limited areas in Manitoba, Saskatchewan and Alberta. Some plantations established in these areas using intensive methods now exceed 80 years of age.

In 1909, the Commission of Conservation was formed as a joint federal-provincial organization to initiate research into forest conservation and utilization, conducted primarily through the universities. This work was taken over by the federal Forestry Branch in the 1920's during which time a national timber inventory was conceptualized, and permanent sample plot programs to measure the growth and yield of important timber species were established.

During the 1930s timber inventories and forest management planning in the prairie provinces progressed slowly, and the depression and World War II further delayed progress. Saskatchewan was one of the first to develop a series of sample plots in major forest cover types, by site and age class, which formed the basis for subsequent yield tables in the 1950s and 1960s, and is still a valuable data base. Another example of early growth and development studies in boreal mixedwoods was the extensive plot system established (1946-1950) by the Forestry Branch in the Riding Mountain area of Manitoba.

In 1949 the Canada Forestry Act introduced cost-shared agreements between the federal and provincial governments. These initially emphasized inventory, fire protection and access, and were the forerunners of current agreements.

Harvesting has always been the primary management-related agent of change in the boreal forest. Until the mid-1950s it was carried out mainly with horses and small tractors, primarily after freeze-up. There was minimal site impact such as compaction or rutting. Harvesting methods were variously referred to as partial cutting, selective cutting, and diameter limit cutting. The clear-cutting system was not extensively applied. Such cutting often resulted in high-grading of valuable conifers, leaving an understocked, often decadent hardwood residual with a much-diminished coniferous component. Even when clear-cutting was applied in mixedwoods it usually resulted in a substantial hardwood residual. This, combined with the failure of many attempts to re-establish conifer plantations on such sites, has left a legacy of large areas of unproductive mixedwoods of little potential value for future timber. It is a problem which persists to the present. This is the basis for concerns that foresters may be in the process of turning the boreal mixedwood forest into the boreal hardwood forest (McDougall 1988). Recent surveys in both Alberta and Saskatchewan confirm the significance of this change.

An Emerging International Context - 1955 to 1992

Since 1955, development, environment, and social justice issues have come increasingly into conflict, and shifted from the regional to the global arena. There are significant implications for both policies and practices in boreal mixedwood management.

Development Issues

Timber as a commodity is still the primary reason for the development of boreal mixedwoods. Forest products continue to be the leading commodity in Canada's manufacturing industry. Activities such as tourism and recreation in the boreal forest, while locally important, are viewed basically as free-goods, and tend to develop following the construction of timber access roads.

Forest Management Agreements (FMA's), embodying the concepts and policies of sustained yield, and multiple use introduced a new phase in boreal forest policy, planning, and practice in the mid-1950s. They still form the basis for major commercial forestry operations throughout the region.

Increased demand for aspen (Table 1) has recently spurred new development in boreal mixedwoods, particularly in Alberta and Saskatchewan. This presents new opportunities for mixedwood management options. This is

Table 1. Utilization trends and current aspen AAC in western Canada[a] (million m^3)

Province	1978	1983	1988	Current AAC	1993 (estimated)	Percent of 1993 AAC committed
Manitoba	0.06	0.16	0.14	1.80	1.03	57.0
Saskatchewan	0.30	0.37	0.84	2.60	1.70	65.0
Alberta	0.05	0.17	0.89	8.40	6.00	71.0
British Columbia (Northeast)	-	-	0.16	3.50	0.16	5.0
All provinces	0.41	0.70	2.03	16.30	8.89	55.0

[a]Summarized from information provided by provinces.

done by increasing the merchantable value and utilization of mixed- species stands, and by introducing policies and opportunities for managing mixed stands. In the past, focus was exclusively on either softwoods or hardwoods. Associated increases in industrial activity have focused public attention on the way in which forest management is practiced.

Sustained yield of timber is now recognized as a limited concept when measured against the new standard of sustainable forest development. Sustainable forest development aims to maintain the productive and renewal capacity and biodiversity of forest ecosystems. It integrates the whole range of economic, environmental, and social values associated with forests. Baskerville (1990) defines sustainable development as a dynamic concept which depends on forecasting, because its primary effects are in the future. Its practice requires adequate knowledge, tools and resources, and it is essential to progress that ends and means are consistent.

"Sustainable development" is now impacting on policies and forest management strategies in the prairie provinces. Integrated resource planning (I.R.P.) is underway using a variety of hierarchical levels. Levels from local to provincial, linked to provincial conservation strategies, are currently being developed with input from groups like the Round Tables on Environment and Economy. Saskatchewan's conservation strategy is scheduled for completion in the spring of 1992, and will subsequently relate to a national conservation strategy. Management plans on FMA's also relate to this planning matrix.

Recent examples include Research and Development (R and D) designed specifically to integrate timber and wildlife management, such as the work of the Integrated Resource Management Steering Committee (IRMSC) on the Weldwood FMA in Alberta, similar work on the Alberta Pacific, and Daishowa FMA's in Alberta, and the Forest Habitat Project in Saskatchewan (organized under Saskatchewan Parks and Renewable Resources).

The move to year-round harvesting to supply an expanding industry with timber has generated highly mechanized harvesting and site preparation techniques, and a move to the extensive application of clear-cutting. These changes have increased the need for better integration of harvesting and silvicultural systems. They have also added operating regulations such as ground rules. One of the most significant changes has been the challenge to actually manage mixed stands as mixedwood ecosystems. This presents perplexing problems to forest managers who recognize the value of mixedwood ecosystems from an integrated resource management perspective, but whose primary experience to date has been managing either for hardwoods or softwoods. Attempts to manage for softwoods on mixedwood sites are still frustrated by competition from aspen, brush, grass and hares (Peterson 1989).

New mixedwood management options are needed, particularly options which will effectively integrate non-timber uses. There is a long regional history of research into mixedwood harvesting and management systems, going back to 1924 in the Pasquia Hills of Saskatchewan, and culminating in assessments of mixedwood harvesting alternatives in the 1960s (Waldron 1991). Practical applications have been limited, with clear-cutting dominating practice since the 1960s. A recent harvesting study to encourage mixedwood perpetuation by protecting understory during aspen harvest (Brace 1989; Sauder 1990) is one example of possible options. Many others are needed, particularly those which work with natural succession, supplemented by planting where necessary,to maintain desired coniferous content.

The interests of the federal government in forestry practices are reflected in regional R and D programs, federal-provincial agreements, and the Green Plan initiative "Partners in Sustainable Development of Forests Program". Model forests, proposed as living laboratories for the most advanced scientific methods, techniques, and forest practices, are the main feature of the program. Programs cover a variety of activities including ways of reducing environmental impacts of forest harvesting, climate change research in the boreal forest, and ecological reserves.

A strong link has been forged, joining boreal mixedwood development to the global issues of ecosystem sustainability, biodiversity, and climate change. This external challenge, coupled with domestic economic self-interest and ethical imperatives is having a unifying effect on resource managers.

Environmental Issues

Environmental issues affecting boreal mixedwood management have changed substantially since the 1960s, and are now global in nature. Public concern is particularly focused on: sustainability of forests, (which includes adequacy of regeneration, monocultures, clear-cutting, loss of wildlife and fisheries habitat); use of herbicides and insecticides; old growth; biodiversity (which is related to both clear-cutting and old growth concerns) and global warming. The recent requirement for Environmental Impact Assessments (EIA's) on forestry operations in Manitoba and Saskatchewan under provincial environmental legislation is the direct result of such concerns.

Environmental impacts of forest harvesting have been addressed operationally since the mid-1970s by both avoidance and mitigation strategies. These include operational ground rules, which have become increasingly more specific with respect to wildlife, and modifications of equipment, which have included changes to tire profiles and adoption of shortwood systems. These measures, and scheduling of winter logging for wet sites, are of particular importance as highly mechanized year-round operations move into boreal mixedwoods.

Site degradation from a timber production perspective (nutrient loss, compaction, rutting, soil displacement, and mass wasting) can result from both harvesting and site preparation. This has been well documented in the literature since the 1960s. It is now limited by law in British Columbia where Preharvest Silvicultural Prescriptions (PHSP's) are required and operating guidelines are being prepared (Lewis *et al.* 1989; Curran *et al.* 1990; Krag *et al.* 1991).

Ecological site classification R and D has a long history. It begins with vegetation-based work by Halliday (1931) in the Riding Mountain area of Manitoba, and progresses through work based on soils and vegetation in Saskatchewan (Kabzems *et al.* 1986), biogeoclimatic classification in Alberta (Corns and Annas 1986) and biophysical work in Manitoba (Pedocan 1988; Waldron 1991). No systems are operational at present. Such systems are needed, in combination with specific inventories, if we are to move beyond stand-level or cover type management, to landscape management. It will also facilitate development of prescriptions to minimize environmental impacts of management practices.

Social Issues

Two of the most significant social issues motivating change in mixedwood management policies and practices are the perceived exploitation of boreal ecosystems as a social justice issue, particularly by aboriginals and women, and the concept of the world and its ecosystems as "home place" (Rowe 1990). The concept of home place and daily news about acid deposition, ozone depletion and climate change have raised concerns. Displacement of aboriginal cultures by rain forest exploitation, and the potential impact of boreal forest exploitation on aboriginal cultures have also raised concern in many quarters.

Regarding social justice, many aboriginals and women share a common experience of being marginalized and exploited. In our society, the situation is acknowledged in Canada's Employment Equity legislation, Affirmative Action policies, and Equal Opportunities programs. They are among the members of our society who most strongly identify ecosystem exploitation as a social justice issue, and will be actively engaged in the environment/development debate at UNCED '92 (Table 2). Recently we saw Elijah Harper's role in the Meech Lake debate, and have heard the Government of Canada state their intention to develop a new relationship with aboriginal people. This includes recognition of the inherent right to self-government, and participation in a reformed senate. This was recently addressed in the Unity Committee Report of March 1, 1992 and has resulted in the subsequent inclusion of aboriginal people in constitutional talks. Ovid Mercredi is taking a strong position on the issue of "distinct society" in the current debate which specifically includes control of land and resources.

The prominence of women in the environmental movement is also linked to the social justice issue. Groups like the Western Canada Wilderness Committee (WCWC), Sierra Club, Alberta Wilderness Association (AWA) and Time to Respect Earth's Ecosystems (TREE), not to mention the numerous "Friends Of" organizations, are energetically led, and/or supported by women. Women are also becoming increasingly influential in technical and professional resource management occupations.

These issues are influencing forest land use policies and resource priorities. They have helped put foresters and other resource managers in the public spotlight where we must become consensus builders.

The Changing Forester

The following illustrates a foresters' changing thoughts and values in the period 1955 to 1992.

Thoughts of a Mixedwood Forester - 1955

1. Timber management within the context of sustained yield and multiple use is good forest management:

    a) Timber management is conifer management and we manage conifers well.

    b) Good timber management is good wildlife management. There is more

Table 2. Canadian Participatory Committee for UNCED 1992

Cultural Survival Canada	U.N. Association in Canada
Project Ploughshares	International Joint Commission
Wilderness Society of Newfoundland and Labrador	Canadian Conference of Catholic Bishops
Yukon Conservation Society	United Church of Canada
Canadian Council for International Co-operation	Presbyterian World Service and Development
Third World Resource Centre	Development and Peace
Native Council of Canada	Canadian Labour Congress
Indigenous Survival International	Canadian Youth Foundation
Assembly of First Nations	Canadian Peace Alliance
Inuit Circumpolar Conference	Women and Environment
National Action Committee on the Status of Women	Education and Development Foundation
Canadian Environmental Network	

game now than there was before cutting.

c) Clear-cutting is probably the only viable silvicultural system for managing boreal forests, for both economic and ecological reasons, especially with mechanization.

d) There is plenty of opportunity to separate conflicting uses in time or space so they won't interfere with logging.

e) Hardwood "weed trees" should be replaced by vigorous young conifer plantations.

2. Silvicultural systems and harvesting systems are separate and incompatible enterprises:

a) Silviculture must adapt to changing harvesting technology.

b) Always minimize harvesting costs.

3. Foresters are capable of managing all forest resources in the best interests of the public:

a) The minority who might disagree simply don't understand.

b) Public input into policy and planning is unnecessary ("trust us").

4. Environmental impacts are something caused by oil companies, mining companies and large cities:

a) Dilution is the solution to pollution.

b) Forest fire causes more environmental damage than anything forestry operations might do.

c) Soil impacts caused by forestry operations will be minimized by time and frost action.

5. Environmental groups and networks in the U.S. are of limited concern to us in western Canada:

   a) They are mainly "impractical academics" who don't understand who pays the bills.

   b) The Canadian public are a sensible lot who share our values.

   c) The involvement of women and aboriginals in actions which might affect forest management is hard to imagine.

6. Development of the timber resource is urgently required:

   a) It's the best source of jobs in the forested area of the region, generating wealth at home and abroad.

   b) Cut old growth first to avoid further timber waste and reduce the threat of insects and diseases due to decadence.

   c) Old growth areas for maintaining dependent flora and fauna, scientific research, and other purposes can be adequately provided in existing ecological reserves, and in buffer strips on streams and lakes.

7. We should really be increasing the "productivity" of treed wetlands by drainage like they do in Finland, providing an excellent crop of conifer timber in the short run.

8. If stand-level management is done according to the technical requirements of sustained yield the forests will be properly regulated and managed:

   a) Ecosystem management has theoretical merit, but stand management is a practical compromise.

   b) Landscape issues which might be of concern for aesthetics and wildlife habitat can be accommodated reasonably well by good stand-level management.

   c) Field application of ecological site classification is impractical. Operational experience will suffice.

9. Sustainable development is what we are practicing in sustained yield forest management.

10. Biodiversity is understood mainly in terms of vegetative "succession" changes in composition structure and function as they affect commercial tree species. Succession is usually interrupted and simplified to make management practical, like they do in agriculture.

11. Climate change occurred during the last ice age and, if inevitable, is remote. Forests have a minor role, if any.

Thoughts of a Mixedwood Forester - 1992

1. Sustained yield of timber is only part of sustainable development:

   a) Sustained timber yield is essential to our economy.

   b) There are more economic opportunities for timber management now that hardwoods are in demand, but increasing potential for conflict with non-timber uses.

c) integrated resource planning in the context of Conservation Strategies, and support from programs like Green Plan should improve our ability to work toward sustainable development. There is no quick fix.

d) There is a high risk of failure in our efforts to achieve sustainable development, unless there is balance between objectives and the resources to achieve them.

e) Ecological site classification, GIS, computer modelling, and Expert Systems would enhance the integration of forestry data, knowledge, and management skills with those of other resource disciplines.

f) The move from stand-level to landscape management will be necessary for effective integrated management.

g) The clear-cutting option must be retained, modified as appropriate, and explained to critics who are convinced it is deforestation. Other options must be developed.

2. Silvicultural systems and harvesting systems should be integrated:

a) There are often economic advantages for achieving both timber and non-timber objectives. Costs to meet stocking and growth goals in mixedwoods are critical, and are related to harvesting procedures.

b) It provides opportunities to minimize environmental impacts,which are ultimately costs, through work-scheduling and matching equipment to site.

3. Professional foresters are moving beyond their reactive and defensive responses to public criticisms of being exploitive and insensitive to nature:

a) Professional foresters are committed to working with other resource professionals to improve forest management.

b) They are aware that more public input to policy and planning is necessary.

4. Environmental impacts of forest harvesting and scarification are of concern, particularly as year-round operations expand into areas which have historically been operated on frost:

a) Operating ground rules require refinement to accommodate both timber and non-timber uses. The practice of treating wildlife concerns as constraints on timber objectives in ground rules requires change. Specific wildlife management objectives should be incorporated up front.

b) Monitoring programs to determine impacts on ecosystem productivity for a variety of resources need to be devised and/or improved. Indices which reflect impacts on biodiversity are essential.

c) A practical ecological site classification, preferably mapped, is needed, and some form of pre-harvest prescription could reduce the potential for negative impacts.

d) Environmental groups are legitimate players in the resource management game, as are aboriginal people. Many have cultures intimately associated with boreal mixedwood ecosystems that see themselves as part of the ecosystems.

e) Forest management impacts are being scrutinized by EIA's, whether we are ready or not.

5. Old growth is more than just a good source of timber:

   a) It remains a primary source of timber because the age class distribution of boreal mixedwoods is skewed to older ages. It is usually most economic to operate older stands due to stem size, and unit area volume.

   b) We should reserve adequate areas of representative, old growth ecosystems to accommodate dependent wildlife and support process research. They can provide a "parts manual" to guide the repair of managed systems which become dysfunctional.

   c) Waste and decadence are usually irrelevant concepts from a non-timber perspective.

   d) The threat of a spread of insects and diseases from decadent, old growth is still not fully understood. Is it a myth?

6. Biodiversity and climate change are complex and worrisome:

   a) We will attempt to respond positively to them with appropriate management strategies, once they are more clearly defined and understood.

   b) Our view of biodiversity is broadening, but still relates mainly to those aspects of the ecosystem-flora and fauna, which negatively affect timber species.

   c) forests cannot be expected to provide unlimited sinks for carbon originating from fossil fuel use.

SUMMARY AND CONCLUSIONS

Prior to 1955 most management activities in regional boreal mixedwoods were oriented to developing a timber economy. Inventory and protection were paramount. Foresters of the day managed within a policy of sustained timber yield. Environmental issues were of minor concern to foresters and to society. Multiple use was considered adequate to deal with resources like wildlife, which were handled as generalized "add-ons" in a process driven mainly by timber objectives. Wildlife was perceived mainly as big game and fish.

Since 1955, development, environment, and social justice issues have come into increasing conflict. These issues have become global in nature and are expressed in the term sustainable development. Sustainable development has significant implications for management policies and practices in boreal mixedwoods. Clear-cutting, old growth, biodiversity, climate change and social justice, and particularly aboriginal rights, are now part of an international debate on environment and development.

Foresters are acutely aware of a professional responsibility to apply their substantial data, knowledge and management expertise in mixedwood forestry within the broader arena of Integrated Resource Management (I.R.M.). Their contribution would be enhanced by adapting ecological site classification, GIS, and computer modelling, (within an expert systems framework), to deal with the spatial and temporal demands of ecosystem management.

Cooperative IRM programs have demonstrated a critical need for specific objectives, more scientific knowledge, and better inventory data to address the management of resources like wildlife. More multi-disciplinary task force programs with effective public input should be encouraged, doing needed research concurrently.

Recent requirements from Environmental Impact Assessments (EIA's) of forest management practices have added urgency to an already challenging work environment. Professional resource managers are taking their first steps to demonstrate sustainable development. Pre Harvest Silvicultural Prescriptions (PHSP's) would help.

The model forest approach has considerable potential, but we must avoid setting unrealistic objectives. We must be aware that politics and public relations can distort reality in such a program; compromising both the science and the practice of sustainable development.

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DISCUSSION

Question by Mr. James: A number of people would advocate short-circuiting your diagram and going from experimentation to the field trials to do two things at the same time. Let's do the field experiments and we can have forestry management get answers to much needed research questions at the same time.

Response by Mr. Brace: Yes, and I think task-forcing has a real potential. Time constraints exist and we have got to move. If you don't have a lot of research, then there is at least a lot of experience. If people could get together and task-force these issues, we could make some pretty sensible moves.

Comment by Mr. James: Everybody in the room should read Stan Rowe's book. It is very good.

Question by Mr. Diamond: I have a certain amount of confusion between what you were saying, and what was said earlier about Wayne Harris's question on managed mixedwood, and which direction it is being driven. I think I have heard two conflicting things. Is that it is all going to become hardwood? Is there is a driving force to maintain it as mixedwood? Could you clarify that?

Response by Mr. Brace: There is a spectrum of composition ranging from softwood through to hardwood. That is characteristic of the system. We are finding that in trying to manage the softwood we are getting mixedwood, regardless of our best efforts. Often when we enter the mixedwood, it tends to move toward a hardwood. It is extremely difficult to maintain a coniferous component in those systems without the judicious use of chemicals. I think what we have to look at from the point of view of maintaining this mixedwood in an integrated resource management context, is more assisted conifer regeneration. We should work with natural systems as much as possible. We are going to have to do some planting to maintain the softwood. The whole system is currently shifting from a softwood toward a hardwood, and depending on where it starts, it will wind up as either a mixedwood or a hardwood.

Question by Mr. Diamond: Is that because the rotation age is being shortened, or is it because the biology of spruce has to come up under shade?

Response by Mr. Brace: It is a combination of things. If we enter a mixedwood with a high deciduous content at age 60 to 80 years, for the aspen, and try to start over with conifer, then we are trying to move from a mid-successional to a late-succession stage. In other cases, that same site, given different circumstances in terms of initial stand composition, may already have a high spruce content. Sometimes, we try to force the stand toward a late succession. Other times, we do not. The biggest problems occur when trying to move directly form early to late successional stages on a given site.

DEVELOPMENT OF AN INTEGRATED MANAGEMENT PROGRAM FOR ALBERTA-PACIFIC FOREST INDUSTRIES INC.

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ABSTRACT

The recognition of the importance of non-timber values prior to the establishment of the boundaries of Alberta-Pacific's Forest Management Agreement (FMA) leasehold in northeast Alberta can make integrated resource planning more successful than elsewhere.

A number of considerations to facilitate the resolution of land use conflicts, in addition to the use of modern technological tools such as geographic information systems, are required. These include the adoption of a positive attitude toward integrated management, the need for research on a variety of topics such as biodiversity and wildlife population dynamics, and an extensive public involvement process.

Research studies include the effects of forest habitat fragmentation on biodiversity, ungulate studies and fur-bearer inventories intended to develop functional relationships between species and habitats. A system using net-down components such as steep slopes and riparian buffer zones as wildlife habitat will be explored.

INTRODUCTION

Alberta-Pacific Forest Industries Inc. signed the Forest Management Agreement with the Alberta government in August, 1991. The FMA encompasses approximately 61 000 km^2 of boreal mixed wood forest and peatland in the mid boreal mixed wood ecoregion of Alberta. The FMA is composed of approximately 49% non-commercial land base, 16% riparian and buffer areas and 10% allocated to coniferous quota holders. The remaining 25% is composed of merchantable mesic aspen and mixed wood forest available for timber harvest.

General Ecology

The northern boreal mixed wood forest has been fire dominated for centuries and was replaced approximately every 40 years prior to fire protection. The resulting units are discrete and generally small in size. They are varied in their species mixture, often composed of up to 6 hardwood and softwood species. There is an extensive wetland-peatland component throughout the area, supporting a mixture of black spruce and larch. The upland component has areas of drier soils supporting pine and white spruce with extensive terrestrial lichen understorys. The complexity of the area is compounded by the juxtaposition and combination of the small, discrete units. White spruce and balsam fir are the climax species in most upland sites but are underrepresented due to the frequency of wild fires. The age structure of the FMA forest has increased to an average and median age of about 60 years. At present the forest contains only about 5% deciduous old growth (depending on the definition of old growth). The first 10-20 years of logging will allow a portion of the forest to age to 80 - 100 years or older. Consequently, it will allow the integration of a larger component of overmature and old growth habitat requirements into the planning process. Development of a main road network will allow Alberta Pacific to utilize this aging portion of the forest. As well, it will also allow the harvest operation to be spread out over a larger area, reducing local impacts.

Provincial Planning Procedures

The FMA has a limited set of statements regarding environmental integration and protection. The majority of wildlife and environmental planning procedures are accomplished through Provincial Government Planning programs such as the operating ground rules. At present, these ground rules are a modification of procedures from coniferous forest ground rules and are only partially applicable to northern mixed wood forests. As area specific information is gathered, the ground rules will be modified to fit the planning needs of the area. The annual operating plan and associated general development plan are currently in the early stages of preparation and will be submitted by April 1, 1992. Similarly, the outline for the Preliminary Forest Management Plan is being formulated and will be developed throughout the next few months. It will be followed by the development of the Detailed Forest Management Plan which is due in 1994.

These plans are not ecosystem plans and only partially include the requirements for biodiversity and forest ecosystem management.

Integrated Planning Framework

Integrated planning procedures are rapidly becoming functions of modern technological tools such as GIS. However, in order for technology to resolve land use conflicts associated with integrated planning, other aspects of the planning procedure are necessary prerequisites.

a) Level Planning Field

The FMA was reduced and modified to accommodate several other requirements such as caribou habitat, riparian habitat, lakeside buffer strips, Lakeland Park, et. cetera. As a result, it was not <u>solely</u> intended as a timber-pulp harvesting operation. In the past, timber harvest agreements accommodated other social or biological requirements after the fact. Consequently, conflicts arose due to the uneven playing field. This FMA agreement has levelled the field significantly.

b) Attitude

Most importantly, the company is developing an attitude of integrated management within its total management framework. Things generally happen because people want them or make them happen. Attitude will play an important role throughout the planning and decision making process.

c) Information

Even with advanced technology, large scale information requirements must be fulfilled in order for an integrated management process to be successful. Research and information systems are being generated on such topics as: biodiversity, fragmentation, caribou population dynamics, limiting factors and habitat requirements.

INTEGRATED PLANNING PROCEDURES

Alberta-Pacific Forest Industries is constructing a 1.4 billion dollar pulp mill and forest harvest operation in north east Alberta. In order to produce approximately 1 500 tonnes of pulp/day the mill requires approximately 2.5 million m^3 per year of raw material. Harvest of fibre for the mill is the first priority within the FMA agreement and will require deciduous (80%) and coniferous material harvested from a 14 000 ha area per year.

In order to integrate this sizeable requirement with the multitude of species habitat requirements, information of all types is a major necessity.

Generally, phase III inventory is available in a non-digitized form for the entire FMA. In addition, detailed forest inventory which meets Alberta Vegetation Inventory (AVI) standards is being collected in each township slated for logging. As well, thematic mapping has been conducted in a specific study area to categorize identifiable components and will likely be completed in a digitized form for the entire area. In addition, 70 mm photography is being used to classify vegetation at a detailed level for several studies, and will be used to correlate ground measurements with photographic measurements.

Extensive studies of forest habitat fragmentation and biodiversity are being conducted in cooperation with the University of Alberta, University of B.C., and AEC (Alberta Environment Centre). In addition, a cooperative caribou research program (Alberta Government, Oil and Gas Industry, University of Alberta, Al-Pac) has recently been initiated, and will be examining various limiting factors and hypotheses. A furbearer inventory program will attempt to gather specific furbearer species information from trappers and relate it to timber inventory (AVI, thematic mapping) information. Other sources of information (habitat mapping, moose range maps, peatland mapping, wilderness area maps, caribou range, et cetera) are being digitized and catalogued and will become part of the environmental data base.

Analysis and implementation of the data base will be handled through the GIS and a variety of HSI (Habitat Suitability Index), landscape, tree growth and species optimization models.

Implementation of any information will require a species or area objective setting process, and a method to prioritize area value and species order.

To date, the lack of objectives for species or species groups has been one of the biggest drawbacks for species or biodiversity planning. Coupled with the lack of quantitative and often qualitative functional relationships between species and habitats, planning has generally been restricted to ungulate - habitat relationships.

In order to realistically plan for the extensive timber harvest operations of Alberta-Pacific; in addition to the wildlife habitat and human social requirements, a broader, more encompassing approach to planning is required. Consequently Alberta-Pacific has initiated an extensive public involvement process which will be addressing the operating ground rules, the Forest Management Plan and other associated environmental issues. A similar process will include native issues as they are affected by the Alberta-Pacific operations.

Harvest Operations

The application of operating ground rules generally involves restrictions on the harvesting of merchantable timber. These include block size, two and/or three pass systems, block shape, green up periods, et cetera. However, due to the demand for fibre and the structure of mixed wood ecosystems, two and/or three pass systems do not adequately manage the ecosystem for individual species, such as caribou or for the multitude of species associated with this ecoregion.

The variation in forest types between townships can proceed from 60 - 80% merchantable to 60% - 80% non-merchantable. In many cases the non-commercial component provides many if not most of the habitat components required by wildlife species. When steep slope areas are combined with riparian buffer strips, lakeside buffer areas and non-commercial areas, the habitat distribution and quality and quantity becomes a basic unit which can support wildlife diversity. Areas of commercial mesic aspen or mixed wood forest can be added to this network to supply much if not most of the remaining habitat requirements. This system allows moderate to large habitat units to become larger, more secure and more diverse with the addition of selected units of commercial forest. At the same time this system allows more flexibility for the forest industry.

The system of using net down components as wildlife habitat will be explored more fully throughout the next two years as information is gathered, and planning becomes more operational.

CONCLUSIONS

Integrated management planning can be more successful in the Alberta-Pacific Forest Industry operation because of the process used to develop the FMA boundaries and the fact that other uses were recognized prior to the boundaries being established for timber harvest operations. Ultimately, success will depend on the calculation of AAC and the flexibility that can be identified in relation to the cut calculation. Subsequently, research information, planning procedures, planning models and decision making systems can be utilized to integrate commercial, social and biological requirements. Although there is no standard procedure to integrate commercial requirements with public involvement procedures, native issues or biodiversity, Alberta-Pacific will play a key role, if not the key role in developing a successful operation.

DISCUSSION

Question by Mr. Lakusta: You indicated that Al-Pac is going to be spending $4-5 million on forest inventory in the next five years.

Response by Mr. Hebert: I am not sure what the time frame is, but yes, in the near future.

Question by Mr. Lakusta: Is that forest inventory money going to be spent in diverse ways to look at things other than fibre?

Response by Mr. Hebert: At present, the majority of the money is going to be spent looking at fibre. I have developed some programs where the people doing that classification will be looking at other wildlife components such as snags, dead and downed, terrestrial lichen, et cetera. There are only so many things one person can classify when doing inventory out of a helicopter over those stands. I am not sure what the upper limit is in terms of what they can actually collect. I am trying to incorporate as many other things into it as I can. I have previously been involved in trying to have foresters and timber inventory people collect other data. It is difficult to do. You have to have a separate system to collect the wildlife data that you need, and then possibly fit the two together. It depends on how many people you have, or the kind of sample size or plot size. It is very difficult to accomplish.

Question by Mr. Pepper: You mentioned that there was a problem getting people to study ecological principles and interactions in the forest ecosystems at the academic level. In various economic studies and what is reported in papers, Canada is behind from the standpoint of funding research, especially in academic institutions. We really seem to be behind in the funding of research through the assistance of industry. I have been attempting to get research started from the government angle, and the wildlife ecological studies standpoint. For many years (in the late 1970s and 1980s), research was a dirty word in government. It appears there is a tremendous lack of understanding of how things work ecologically in the forest ecosystems. In many ecosystems on the prairies, funding seems to be a problem. From Al-Pac's standpoint, do you see any opportunity for arrangements to be made between forest industries and academic institutions to fund some of these research studies?

Response by Mr. Hebert: I think there is lots of opportunity, Wayne. The only thing that limits us right now is our initiative and our imagination. I am trying to set up research programs with the University of Alberta, the University of B.C., the Alberta Environment Centre, and the oil and gas industry. The universities are certainly becoming more involved in some of the industrial problems. The industry and government are at a point where it is undecided who should pay for some of this research. The governments would like to switch it all over to the industry and have them pay for everything. Industry would like to have governments pay for everything. That particular battle is going to go on for a number of years. I am sure in the end, the costs of research are going to be shared. Now, there is really no method for that kind of cost sharing between industry and government and certainly no formalized methods to cost share with universities. Most of the research I have been involved with over the past 20 or 25 years with universities in British Columbia and Alberta have been due to individual initiative. It hasn't been due to an industry-academic relationship or an industry-government relationship. It has been individual initiative. There are more problems now and it is going to require cooperative funding and cooperative research activity between industry and government and industry and universities. If we can get this particular plan through the University of Alberta and into the Green Plan funding it will be a good prototype for other places and other governments across Canada.

Comment by Mr. James: A company that can afford to spend $1.4 billion building a pulpmill, and spend money extracting the fibre, can surely afford to support, the answering of research questions that would help them. I think that industry should start supporting research more than it has in the past.

Response by Mr. Hebert: I don't disagree with you. The industry side is not an open well full of money that you dip into at any time. Industry has very specific objectives. Industry acquires money to meet those objectives, more specifically than government does in terms of research or even in terms of management. Part of my trial (over the next year or two) will be to see how successful I am in getting some of that money directed into research programs that I know have to be done. The attitude in Al-Pac is better than any other industry that I have worked with. The people in Alberta-Pacific are good. I work for the vice-presidents of Pulp and Woodlands. Both of these people come from the east Kootenays in B.C. Both of them grew up as hunters, fishermen, naturalists and outdoor people. They do things that involve wildlife in one way or another. I was starting with two people who had an attitude about wildlife somewhat similar to my own. My next step is to take that attitude as far as I can in changing direction in the company, the forest service, forest management, and in acquiring funds through the company or wherever I can acquire them, to help resolve these problems facing all of us in the management of wildlife.

Comment by Ms. Cumming: I think we are missing the point. Not all the onus can be put on industry to change and do things. Most of the change has to come from within society. We have to reduce our demand for forest products and reduce how much we use. We should put the mill in places like Edmonton, Winnipeg, or Saskatoon. Put it in a big population centre and recycle and reuse the paper products instead of going after more and more from our diminishing wildlands. I think companies are heading in the wrong direction. There should be more onus put on everyone to change our mindset for reducing and recycling rather than going after our supposedly renewable resources.

Response by Mr. Hebert: It is a good point. I had an interesting observation when I was sitting in on the Al-Pac hearings a year and a half ago. I have always been a firm believer that Canadian productivity, climactic limitations, soil limitations, and physiographic limitations have been stretched beyond carrying capacity for a number of years. We are going to continue to live beyond carrying capacity and live with an accumulating debt. I sat in on the Al-Pac hearings a year and a half ago and watched the opposition to what Al-Pac was doing, and I didn't disagree with what the people were saying. I think everybody has a right to say something should or shouldn't go ahead. I watched a lot of those people come in and oppose what Al-Pac was doing, and then put on their $200 ski jackets, get into their $30 000 cars and drive to their $200 000 homes. From my personal viewpoint, I could go back to living at a much lower standard of living than 99 percent of the people in this country. I would have no trouble doing that. We are always in a conundrum as to whether the people are driving industry or whether the industry is driving people, in terms of their wants and requirements. This is still the issue that is the most important. I think that until we resolve the question of our standard of living and what people really want and require, we are not going to solve the problems of biodiversity and management for wildlife. The underlying principle is human requirements, wants, and needs. People don't care where they get it from most of the time, and people don't understand what the consequences are in relation to what they feel their standard of living has to be.

Question by Mr. Moller: It will be a while before you will get an analysis from your integrated management process. In the meantime, what is your idea of the size of area to be managed for the species that are dependent on the vegetation climates? How are they going to be distributed?

Response by Mr. Hebert: I can't answer that question, because we are in the process of collecting information now. Look at the ground rules that have been tentatively agreed to, and then you know what some of those conditions are in terms of 25 to 40 hectare cut blocks, two-pass, or three-pass systems. I feel we have to get beyond the traditional standard stuff to do things properly. Most of my effort over the next year or two is going to be trying to get beyond those traditional ways of doing business. Two of the things I was able to do was to make sure that ground rules are preliminary and tentative and will be developed over the next two years as we approach the detailed forest management plan. What we agreed on is just a beginning point. We are going to have to have a government biologist work with us on the planning procedure. He is going to sit with us as we develop the forest management plans. He is not going to be at the back end of the process. Until we get more upfront planning and knowledge, we won't get beyond those traditional ground rules that we have in place at this point in time.

Question by Ms. McAdam: You have graphs on your diagrams. One of them showed the position of the Parks people to areas they wanted protected. Who are they?

Response by Mr. Hebert: Alberta Wilderness Association.

Question by Ms. McAdam: There was another one on sensitivity, that seemed to overlay the parks, and then there was another one on the proposed cuts. There was one large area sort of central in the diagram, and the cut seemed to go right through the sensitive area that was a proposed park. How open you are to discussion with the Parks people about that?

Response by Mr. Hebert: I think we are quite open. I have spent the last six months working with the Alberta Wilderness Association to put the timber harvesting plan together with their requirements for wilderness areas. I don't have any doubt that somewhere in northeastern Alberta we are going to have a boreal mixedwood wilderness area. It is a matter of where it is going to be, how big it is going to be, and how many there will be. We have spent a lot of time working with the AWA. The problem is they don't have any information on how they identify their wilderness areas. They are very rough lines on a map drawn by people that flew over them or drove by them. In order to make resource trade-offs, we are going to have to have better information on those areas. That has got to be part of the process, and we are trying to work with that. We are trying to have them with us when we talk about a data conservation grant, a data conservation centre and providing information to identify more clearly what those boundaries are and what their reasons are for establishing individual areas.

Question by Ms. McAdam: May I suggest a study of that particular area especially, because it seems to overlap on both the park and the sensitivity issue?

Response by Mr. Herbert: We have all that information on the GIS system, and we will be looking at that kind of information in a combination of overlays in the next few months.

SESSION 5

DATABASES AND INFORMATION NETWORKS: WHAT DO WE HAVE AND WHAT DO WE NEED?

Chair: Wayne Pepper
Saskatchewan Dept. of Natural Resources
Regina, Saskatchewan

EXPANDING FORESTRY CANADA'S PERMANENT SAMPLE PLOT CATALOGUE TO MEET THE NEEDS OF INTEGRATED RESOURCE MANAGEMENT

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ABSTRACT

Integrated resource management involves the use and interpretation of diverse data to assist managers in arriving at land use decisions that do not compromise the overall biodiversity and renewal capacity of the nation's forests. A database that could be of value in furthering integrated resource management is Forestry Canada's Microcomputer Permanent Sample Plot Catalogue (MPC). The MPC was intended to act as an information transfer vehicle about permanent sample plots that Forestry Canada has monitored as far back as the 1920s. The purpose of the MPC was to enable ready access to a vast pool of scientific information by researchers and natural resource practitioners for use in applications for which the data may not have been originally intended. Other forest management agencies and forest products companies became interested in the project and contributed data about their permanent sample plots. The paper discusses the need to update and expand the MPC with more plots in deciduous and mixedwood stands and in younger age classes. The paper concludes with a discussion about a proposed general catalogue of databases that deal with the management of natural resources across the region.

INTRODUCTION

The title of my talk begs the question: What are the needs of integrated resource management? Some sort of definition of integrated resource management (IRM) is in turn required before we can answer that question. A precise definition is elusive but certainly the goal of integrated resource management is to utilize all the benefits of the forest resource in a manner that does not compromise the forest's biodiversity and renewal capacity. Integrated resource management is considering and planning for all resources in the same area at the same time, using an interdisciplinary approach (Holtrop 1987).

The principal objective of this workshop is to determine ways to assess the impacts of forest management practices on songbirds in the mixedwood forests of the region. The impacts to be assessed are the effects on bird populations and species richness. Stated another way, the needs of integrated resource management are to develop quantitative forms for the functional relationships that characterize wildlife population response to the implementation of habitat management strategies at the forest level (Baskerville 1991).

Quantitative forms to describe functional relationships, however, can only be proven to be reliable when data are available to validate them. The acquisition and analysis of data is an essential component of our work as resource practitioners. The merging of diverse sets of data assist us in understanding complex interactions in the ecosystem, interactions that mankind often engenders. This paper discusses a database that may contribute to furthering the practice of integrated resource management.

SCALING DOWN FROM THE FOREST TO THE STAND

It is important to manage at the forest level because it is seldom possible to optimize all resources over a small area like a forest stand or a clear-cut at the same time. There are plenty of studies that suggest clear-cutting, and the resultant fragmentation of the forest, has negative effects on some various bird species, however, the goal of management is to maintain viable populations of all species of wildlife across the forest estate.

The forest is, of course, composed of many stand or site types, and forest management practices like clear-cutting are usually performed on a stand by stand basis. Information on the ecology, growth and successional characteristics of the major stand types, as a minimum, is necessary to "roll up" information to the forest level. The collection and analysis of forest site and growth information has always been an important component of forest management. The development of yield tables and computerized yield projection systems requires access to historical tree and stand growth information.

Forestry Canada (formerly the Canadian Forestry Service) has a long history of forest site and growth studies through repeated measurements of permanent sample plots (PSPs). Securing this data represents a considerable investment in time and resources. The accumulated value of these plots has been conservatively estimated to lie between three and four million dollars. In addition to costs expended on data acquisition, this data has an intangible value as it consists of unique, irreplaceable time series measurements, some of which date to the 1920s.

FORESTRY CANADA'S MICROCOMPUTER PERMANENT SAMPLE PLOT CATALOGUE

Forestry Canada has long been aware that these historical measurements form a vast pool of scientific information potentially useful for a variety of purposes for which they were not originally intended. Much could be learned from re-examining existing data sets and historical experiments which were not established with the objective of studying biodiversity *per se*, but which may yield valuable additional information (Boyle 1992). The recording of these measurements had unfortunately not been conducted in an orderly, standardized fashion. Data were stored on paper or in computer files in all sorts of formats in little-known locations, making access to these data impractical.

The purpose of the Microcomputer Permanent Sample Plot Catalogue (MPC) was to make these data readily available to researchers and foresters through the use of a micro-computer database. It was intended as an information transfer vehicle. Work on the database began in 1986. The volume of data presented a formidable task of interpretation and assessment. During the course of the work, other forestry agencies in the public and private sector expressed interest in having their permanent sample plots included in the catalogue. The MPC currently contains information on permanent sample plots from five government agencies and forest products companies (Appendix 1) across the Northwest Region (Figure 1 and Figure 2).

The MPC is a relational database of permanent sample plot characteristics (Appendix 2) combined with menu-driven search and browse software into one ready-to-use package. Users can search for plots meeting specific criteria (Figure 3) using an iterative process in which repeated searches act on successively smaller subsets of the database to speed up the search process. The MPC is available from Forestry Canada in a package that has a user's

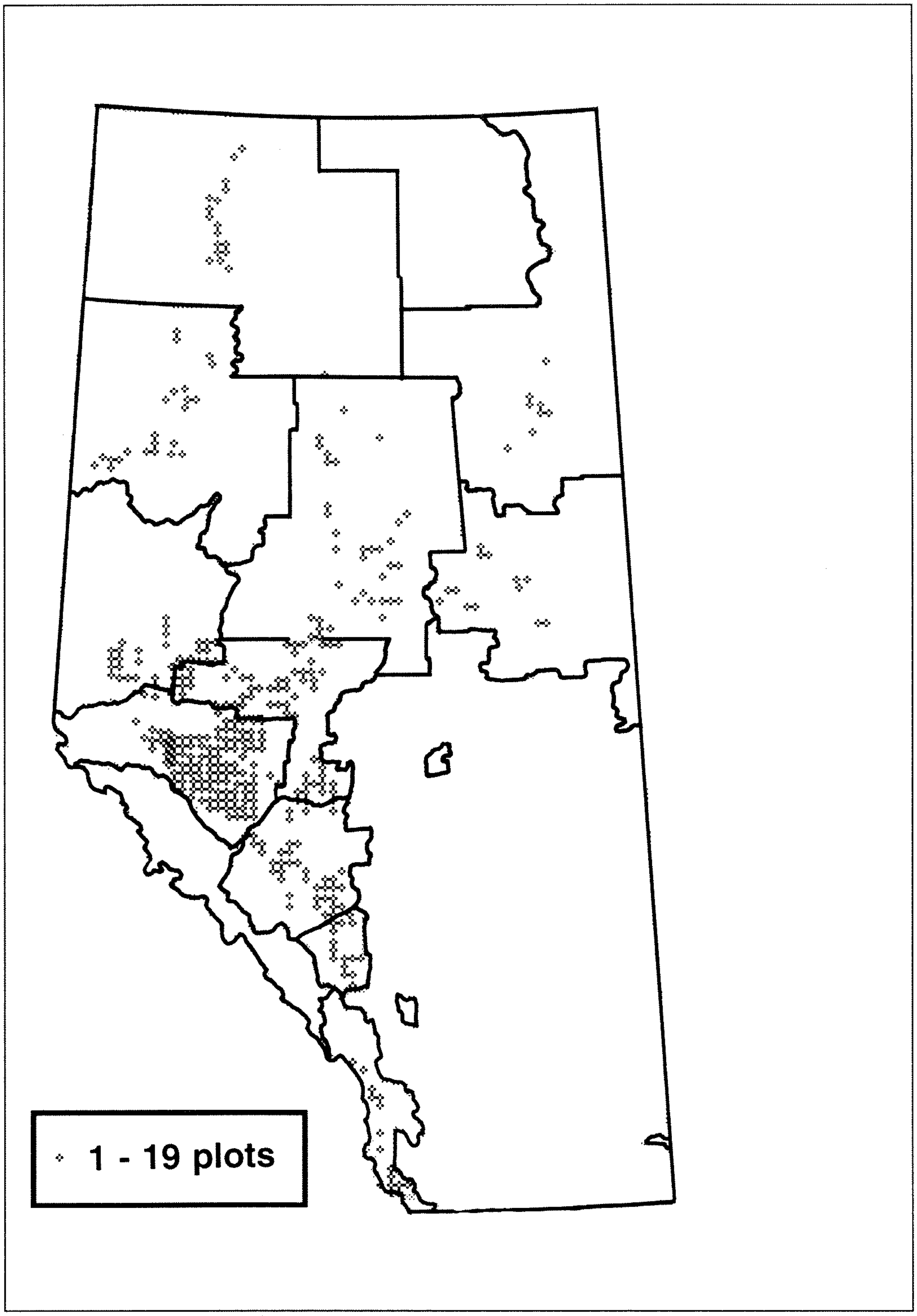

Figure 1. Distribution of permanent sample plots in the MPC across Alberta.

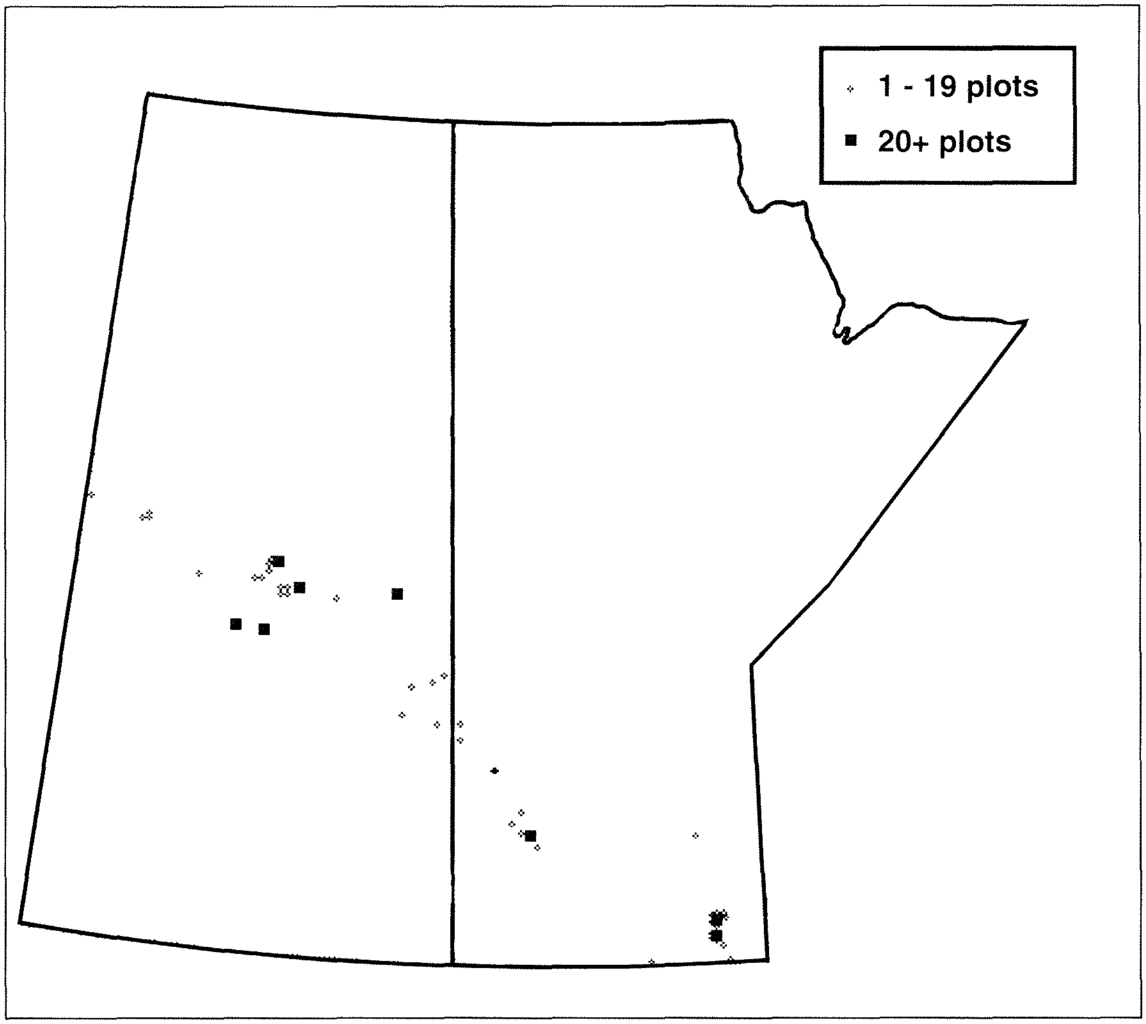

Figure 2. Distribution of permanent sample plots in the MPC across Saskatchewan and Manitoba.

manual with the database and software on a diskette enclosed in the manual. No commercial application software is required to operate the MPC.

EXPANDING THE MPC

Most Forestry Canada plots in the MPC have been updated since 1989 when the MPC was released, but a substantial amount of research work remains to be placed in the MPC. In addition, no effort has been made to pool updates performed by other agencies. New permanent sample plots established by other agencies since 1989 need to be entered into the MPC as well, especially plots established in mixedwood and pure deciduous forests given the importance of these forest types from forest management and integrated resource management perspectives. Only 445 plots recorded in the MPC were established in mixedwood stands and 356 plots were established in deciduous stands. The primary species on 78% of the plots in the MPC are greater than 80 years of age as of 1989 (Appendix 1). The harvest of older age classes with their replacement by younger ones over a rotation is a traditional forestry axiom, but a trend towards a younger forest estate as the natural old growth forests disappear may not be desirable in an integrated management context. It is essential to establish more plots in younger stands, especially managed stands, to determine not only the growth and yield of these plots for

MICROCOMPUTER PSP CATALOGUE SYSTEM
CATALOGUE SEARCH ROUTINE
STAND AND SITE CONDITION

PRIMARY SPECIES:		___	OR	___	
SECONDARY SPECIES:		___			
AGE AT ESTABLISHMENT:		___			
SITE QUALITY:		___			
ELEVATION (M):	MINIMUM:	___	OR	MAXIMUM:	___
ASPECT (DEGREES):	MINIMUM:	___	OR	MAXIMUM:	___
SLOPE (PERCENT):	MINIMUM:	___	OR	MAXIMUM:	___
MINIMUM NUMBER OF MEASUREMENTS:		___			
INITIAL TREATMENT TYPE:	___				
OTHER TREATMENT TYPE:	___ OR	___			

F 1 - HELP CODES F 8 - GO TO PREVIOUS PAGE
F 9 - GO TO NEXT PAGE F 10 - EXIT AND SAVE SELECTION

Figure 3. An example of a screen menu in the MPC to search and select plots.

timber supply planning but also to measure the effects of a younger forest estate on non-timber attributes including bird population characteristics. An ecological land survey (ELS) is an essential vehicle for achieving integrated resource management. Ecological land survey is a means of simplifying and organizing a very diverse body of data in a way that allows research managers to address complex land use/resource development issues, for both long-term planning and day-to-day management (Ironside 1991). Many of the permanent sample plots in the MPC are not classified with respect to an ecological land survey. Doing so would, however, increase their utility for IRM work through combination with ELS-related resources measured in or near the plot that are usually not recorded in the course of normal plot remeasurement.

Even greater value could be gained from establishment and remeasurement of new and existing permanent sample plots through the measurement of additional variables. A few minutes of additional time per sample plot spent in describing details of the plant community structure, including abundance of snags and percent ground cover by dead and downed material, may provide information on the site's suitability for certain bird species, for example. It has long been known that greater attention must be paid to including standing and downed dead material in forest inventories (Hunt 1989).

The MPC is a database with a specialized purpose, an information transfer device about permanent sample plots geared towards forest growth and yield studies. A number of ways to update and increase the utility of this database have been explored above, however, Forestry Canada will explore widening the scope of the MPC.

THE INTEGRATED MANAGEMENT DATABASE CATALOGUE

Over the course of my career as a forest resources analyst, it has become evident that numerous environmental and natural resource databases owned and maintained by many private, non-government and government organizations exist across the region. There are approximately 54 databases within the federal government alone that are concerned with the monitoring and status of various aspects of natural resources (Table 1). The IMDC would also contain information about any land holdings, whether intended for research or environmental monitoring, from which the databases stem.

Table 1. Number of databases by federal department related to environmental monitoring and description of land and surficial natural resources[a]

			Environment Canada	33
			Forestry Canada	15
			Energy, Mines and Resources	1
			Indian and Northern Affairs	3
			Agriculture Canada	2
			Total number	54

[a] Adapted from Keddy and McRae 1989; McRae 1990; Keddy 1991.

Contacting the various agencies and organizations about the IMDC concept is expected to get underway this summer.

A catalogue of land holdings by organization can act as a technical transfer catalyst between disparate organizations to further integrated resource management. This would avoid costly duplication of effort or provide insight on how similar work may proceed based on the experience of other organizations and researchers. Because of the diverse nature of IRM, the IMDC will have to be more general than the MPC, however a number of fields in the MPC are directly applicable to the IMDC. A preliminary outline of the IMDC is presented in Tables 2 and 3.

SUMMARY AND DISCUSSION

Much of the boreal forest is now assigned to forest products companies through various tenure agreements. The time to start examining the effects forestry has on birds and other wildlife is here, not at some point in the future when it may be too late. Although much of the population may not know what an ovenbird or a black and white warbler is, I would wager that most Canadians would be alarmed to hear that these species are declining or threatened over broad areas. It is the public through a plethora of environmental interest groups and public consultation mechanisms that are demanding natural resource managers, and foresters in particular, ensure the preservation and conservation of all living things in our forests.

Integrated resource management can be viewed as another expression for biodiversity, or the maintenance of biodiversity. The concept of "forest inventory" (or other single-purpose databases) must expand to include more florisitc and faunistic elements (Burton *et al.* 1992).

Forests are complex resources with life processes and dynamics that generally proceed on a spatial and temporal scale that hamper efforts at management at the forest level. Technological advances like geographic

Table 2 . Proposed structure of the Integrated Management Database Catalogue

DATABASES	DATA FIELDS	COMMENTS
Database 1	Owner agency	
	Purpose of database	Short paragraph
	Period of record	Start and end dates
	Keywords	Search keywords
	Variables measured	Name, units, location and frequency of update
	Acquisition methods	Short paragraph
	Software requirements	
	Publications	Citations of articles and books of studies based on database
	Contacts	Names and addresses
	Land holding	Cross-reference link
Database 2	Owner agency	
	Purpose of database	Short paragraph

Table 3. Integrated Management Database Land Holdings Catalogue

Name of land holding	Attributes	Comments
Name	Location	Geographic coordinates
	Description	Short paragraph with percent forest, percent water, etc.
	Biogeoclassifications	Biogeoclassification identifier and area
	Purpose of land holding	Short paragraph
	Date of establishment	
	Tenure arrangements	Short paragraph
	Area of land holding	
	Cross-reference link	Link to IMDC database catalogue

information systems coupled with decision support models supported by information from a broad range of ecological elements in databases that are multi-disciplinary, or in database catalogues like the MPC and IMDC that can direct resource mangers and researchers to appropriate data sources, will go a long way towards meeting the information needs of integrated resource management.

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DISCUSSION

Question by Mr. Diamond: I wonder what the minimum size or usual size of most of these plots is. For some bird species, for example, you normally work with a minimum plot size of about ten hectares. Are these plots in that sort of order of magnitude?

Response by Mr. Kuhnke: Ten hectare plots would be the largest of these plots. The majority of them range around a tenth of a hectare. Don't forget that there are often five, ten hectare plots to a stand usually along some sort of transect.

Question by Mr. James: I have two questions. First of all, how often approximately would these plots be resurveyed, and secondly, would you have any objections to ornithologists piggybacking on your excursions so they can do some point counting of birds at these spots?

Response by Mr. Kuhnke: I'm very glad you asked that question. On average, the forestry PSPs are updated every five years. Some are updated every two years. Certainly having people of different disciplines like ornithologists or vegetation specialists along on these remeasurements would be a very good idea, and I certainly I would say that Forestry Canada would be very amenable to this kind of thing. I'm sure that other agencies would want to do the same.

Comment by Mr. Brace: I think that if we want to fast-track some of the older projects in Forestry Canada, it would be a good idea to include in that cataloguing effort some kind of a structured interview with some of the older people that actually established and worked on these projects in the manner in which you structure interviews to provide input into

Appendix 1.
Distribution of permanent sample plots in the MPC by owner, primary species and age class (continued)

		Age class[a] (yrs.)								
Owner	Species	0-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total
Alberta	SW	1	0	1	5	5	40	30	59	141
Forest	PL	0	6	18	35	88	30	7	30	214
Service	AT	0	1	7	2	1	1	0	0	54
	FB	0	0	0	0	0	0	3	14	17
	SB	0	0	0	2	4	5	3	12	26
	LT	0	0	11	14	0	0	0	0	25
	AB	0	0	0	0	7	0	1	1	9
Subtotal		1	7	37	58	105	76	44	116	444
D.N.R. (Sask.)	SW	0	0	0	8	29	20	19	15	91
Total		25	335	205	396	1407	698	269	760	4095

Note: SW = white spruce; PL = lodgepole pine; AT = trembling aspen; PJ = jack pine; H = hardwoods; SB = black spruce; PR = red pine; AB = balsam fir; LT = Tamarack; CE = eastern white cedar

a
Referenced to 1989

Appendix 2.
Structure of the Microcomputer Permanent Sample Plot Catalogue by category of information

Administrative	Plot number	Numeric code (6 digits)
	Project name	10 character alpha/numeric sequence
	Owner code	4 character alpha/numeric sequence
Geographical location	Province	2 digit character code
	Reference Type	1 digit indicating UTM or township/range
	Township/Zone	Maximum 3 digit numeric sequence
	Range/easting	Maximum 3 digit numeric sequence
	Meridian/Northing	Maximum 3 digit numeric sequence
	Biogeoclimatic zone	3 character sequence (Alberta reference)
	Volume Sampling Region	2 digit numeric code (Alberta reference)
Plot attributes	Status	1 digit flag describing current status
	Area	4 digit numeric sequence (m^2)
	Minimum dbh	Minimum tally (cm): 4 digits
	Units	1 digit flag for units of measure
	Type of information	3 digit numeric sequence (data resolution)
	Stem map information	1 digit flag indicating map availability
	Stem analysis data	1 digit flag indicating data availability
	Soils information	1 digit flag indicating data availability
	Regeneration information	1 digit flag indicating data availability
	Damage	1 digit flag indicating severity of damage

Appendix 2.
Structure of the Microcomputer Permanent Sample Plot Catalogue by category of information (continued)

Site attributes	Elevation	4 digit numeric sequence (m)
	Aspect	3 digit numeric sequence (degrees)
	Slope	3 digit numeric sequence (%)
	Position	1 digit, position of plot on slope
	Landform type	10 character sequence indicating material composition and surface expression
	Drainage	1 digit numeric code
	Site quality	1 digit numeric code
Stand attributes	Primary species	2 character sequence for tree species
	Composition	3 digits - % volume for primary species
	Secondary species	2 character sequence for tree species
	Composition	3 digits - % volume for secondary species
	Stand age (establishment)	3 digit numeric value (years)
Benchmark dates	Date 1	2 digit numeric value (establishment year)
	Date 2	2 digit numeric value remeasurement 1
	|	|
	Date 10	2 digit numeric value remeasurement 9
	Treatment date 1	2 digit numeric value for year of treatment 1
	Treatment date 2	2 digit numeric value for year of treatment 1
	|	|
	Treatment date 10	2 digit numeric value for year of treatment 10
Benchmark treatments	Treatment 1	3 digit code for treatment 1
	Treatment 2	3 digit code for treatment 2
	|	|
	Treatment 10	3 digit code for treatment 10

THE APPLICATION OF ADAPTIVE MANAGEMENT STRATEGIES TO INTEGRATED RESOURCE MANAGEMENT

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Melville, Saskatachewan

ABSTRACT

The conventional practice of using constraints on timber management to conserve and protect non-timber forest values is opposite to that of management. The implication of a constraints approach is that timber management will always be the favoured goal, hindering progress towards the achievement of goals set for non-timber values. The only way to integrate timber and non-timber uses of a forest is to actively manage both in the same process. Instead of constraining timber management, management activities should be designed to create the patterns in the forest that will support wildlife and other non-timber values.

This can be achieved by adopting adaptive management strategies to replace conventional research methods. Each management step in adaptive management is treated as an experiment. The results of each experiment are closely monitored to recognize cause and effect relationships that form the basis to modify management, if the effects do not achieve desired goals. Public input into the setting of goals is important as is the use of existing tools, and the recognition of the value of what is already known.

A definition of integrated resource management is the harmonization of the allocation, management and conservation of land. Harmonization is the task we have in front of us. There are decisions that have to be made today. There is a lot known about the forest. This paper is going to focus on the direction that we can move together to get where we want to be in the short term. Waiting another 15 or 20 years is not necessary for expensive research to make some very good decisions about how to manage the land base.

The forest supplies many benefits to us. It has regulation functions which can be summarized into essential life support systems, and production (functions like oxygen, water, building materials, fuel, energy, and carrier functions (Figure 1). Carrier functions are all things that relate to our habitation, forest industry, recreation, hunting, fishing, trapping, and bird-watching. Information functions that are the cognitive development and re-creation types of processes can go because we have the forest.

The important consideration that has to be given to the process is the understanding that there is a joint supply. There are joint supplies coming from the land base when referring to the commercial forest, the forest that is being managed for timber production. One joint supply is timber. The other is non-timber. These are what we need to integrate through some process.

Natural forces and human activities have impacts on forest succession (Figure 2). They ultimately expresses themselves in the resulting type of forest structures. They are expressed both temporally and spatially. Concepts of integration are not usually attended to by looking at the spatial and temporal components in decision-making. The focus is very often on the short term rather than the fully managed state over the rotation of the forest down to the activities on

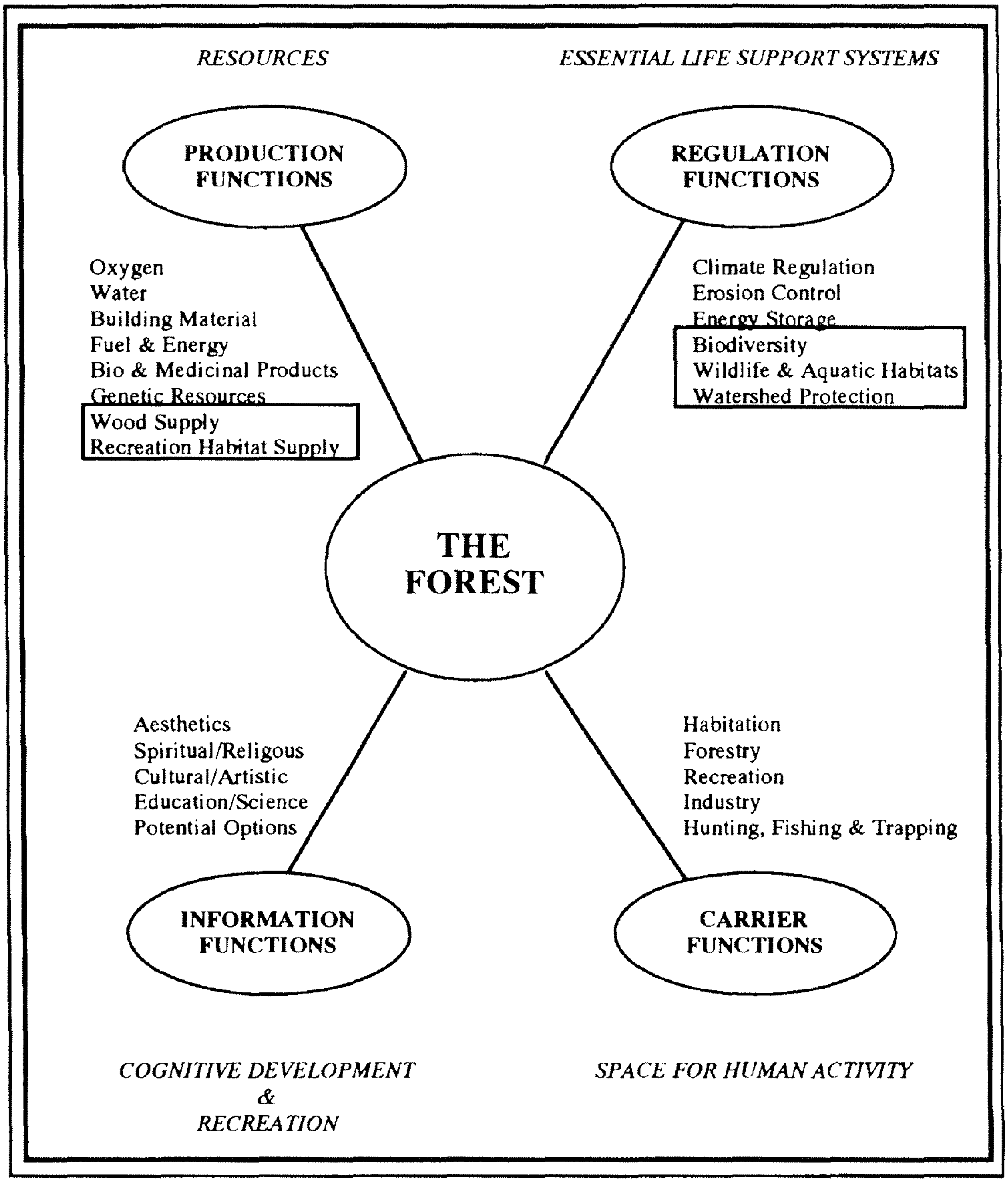

Figure 1. Functions of the forest.

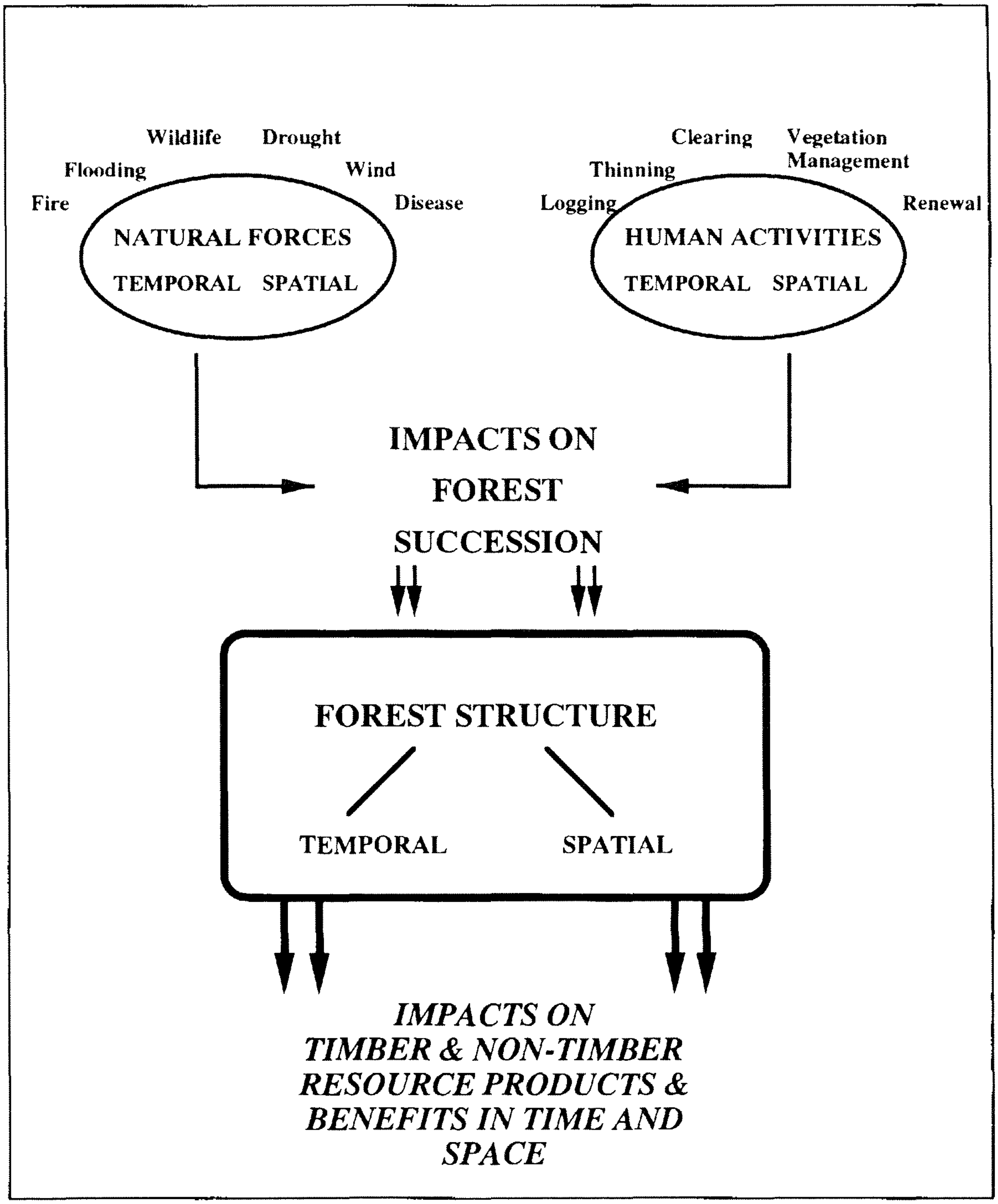

Figure 2. Relationship of natural and management-driven forest processes.

the land base which can be expressed in a period of one year. There are benefit supply analysis and a whole series of activities that go along in each state. Responsible managers need to develop systems through which an appreciation can be gained for events during that whole range of time.

A lot of the material in this paper is heavily imbedded in Baskerville's philosophy because of my belief that he has put so much thought into how the integration process should work. The only way to integrate timber and non-timber uses of the forest is to actively manage both in the same process. This is critical to our thinking. Timber, birds, moose as well as other non-timber benefits in all their compartmentalized segments cannot be managed independently. They have to happen at the same time. The integration process therefore has to be worked on by both industry and government. They must be involved in the beginning of the process for the development of timber management plans. It is not sufficient to be reactive.

The conventional approach in many Canadian jurisdictions has been to use constraints. Baskerville quite clearly states that using constraints is just the opposite of management. When talking about constraints, management by guideline is proposed which attempts to establish a whole series of guidelines and constraints. A number of questions arise if timber is constrained against wildlife, recreation, cultural values and the whole series of non-timber resources. What kind of timber industry are we going to end up with? What kind of forest are we going to end up with once we go through that whole process?

Moose biologists may be able to work with the timber industry to develop some reasonable approaches to managing moose and timber. Will this take into account the concerns for other non-timber values and other people's use of the forest? The answer seems to be quite unlikely. Instead of a constraint approach, timber management activities should be designed to create the patterns in the forest which will best suit a range of activities, not just selective wildlife management. The implications of a constraints approach is that timber management will always be the favoured goal. Progress will be hindered towards the achievement of goals set for non-timber values.

The opposing view to committing large amounts of money to research, is to get involved with the forest development process of timber management by applying adaptive management strategies. This is a process by which lessons can be learned and proof can be obtained about what is actually happening in the field.

There is no crisis in Canada where non-timber values are at serious risk. In Saskatchewan, the annual allowable cuts are relatively low compared to long-run sustained yields. There is a lot of flexibility and time to do things correctly. The same may be true in Alberta, but it may not be the case in New Brunswick or Ontario. The best knowledge in developing timber management plans can be applied, as well as learned, through effective monitoring systems.

Adaptive management recognizes the dynamic nature of forests. It addresses and provides methods to deal with uncertainty. This is one of the big problems that researchers face. Forest or agriculture statisticians from universities talk about 95 percent, 99 percent confidence limits on data, and are not being willing to make concessions unless assured that 19 times out of 20 data are going to be right. The result is frequently unwillingness or failure to make decision. In particular, governments have been bad for not being willing to take risks. Adaptive management gives us a process in which we can take risks. Another approach would be to treat each management step as an experiment, rather than waiting for all the data.

There are 200 000 hectares in Ontario and 10-12 000 hectares in Saskatchewan currently being harvested annually. A system of integrated resource management and adaptive management would permit forest managers to conduct thousands of experiments respecting cause and effect relationships.

We must recognize that monitoring of forecasts provides the experimental evaluation tool. Monitoring is the key in any game plan established. Money is required in monitoring systems; long-term monitoring systems that provide feedback. The ability to develop long-term knowledge will result only if financial resources for monitoring are provided.

For example, some people are concerned about Canadian warblers. They are one evaluation tool, but how can the forest be managed specifically for 150 different songbirds? The forest can only be managed to try to supply the habitat that most of those birds require. This is the challenge; to develop forest management systems to protect those values in the forest based on prior knowledge.

Is it important to know exactly where the bird breeds if its life history is tied into a particular forest structure? Knowing that it exists in a particular forest structure, we want to maintain that forest structure. What the forest structures are and which ones are important are needed to incorporate them into the management planning game.

The first thing that has to be done is to make sets of forecasts of reasonable possible futures. There are a million different ways to harvest the forest. Every forest design will develop a unique set of management plans for a defined area. The forecast of impacts is the only rationale way to compare approaches. There is a reality here that is attended to by a set of principles around which we manage. Once we come to that point, we have to compare the potential options and their costs and benefits. We have to take specific actions that have an appropriate cause/effect connection with forest dynamics, and through adaptive management, and periodically measure the results of those actions to see if they are bringing the results closer to the goal.

One management option is to have no timber management activity. That is a management alternative, and it is one that has to be evaluated. The forest is going to change in time and space in the absence of timber harvest. The associated habitats for recreation, wildlife, and whatever are also going to change in time. Look at it 5 years, 20 years, 100 years into the future increasing levels of uncertainty, but nonetheless without the fear that it cannot be done.

There are a reasonable number of options that exist. For example, if dealing with wood, tourism, moose, ovenbirds, biodiversity and water quality, there are specific targets that can be established for each of these components of the forest. The first option could be to produce 100 units of wood, 30 units of tourism, etcetera. The second option may have 1 000 units of wood and 100 of moose (Figure 3).

These can now be evaluated in economic terms. There are tools that allow expression in commensurate terms, when wood products and wildlife products are derived from the same forest structure. An understanding of how to valuate these products and how they can be expressed against wood supply must be worked on.

Successful evaluation will result in a preferred option, and a cost-benefit analysis that can be expressed in economic terms. This is an economic world, therefore it is important that terms are expressed so that everyone is able to understand them.

For example, how much is a moose worth? Is it expressed because people are willing to buy a hunting licence and drive a number of miles to shoot a moose? Is that the value of a moose or does society have a greater value for moose? These are the things that must be done in the short term to be able to practice integrated resource management in a realistic sense and in one that we can be explained to people.

The other aspect that cannot be forgotten are public priorities. Professional biologists or professional foresters do not have the right on Crown lands to manage the forest as they see fit. Public input has to be assured in the process (Figure 3). We must work together towards designing principles and the objectives. Objective targets must be set that represent values, and

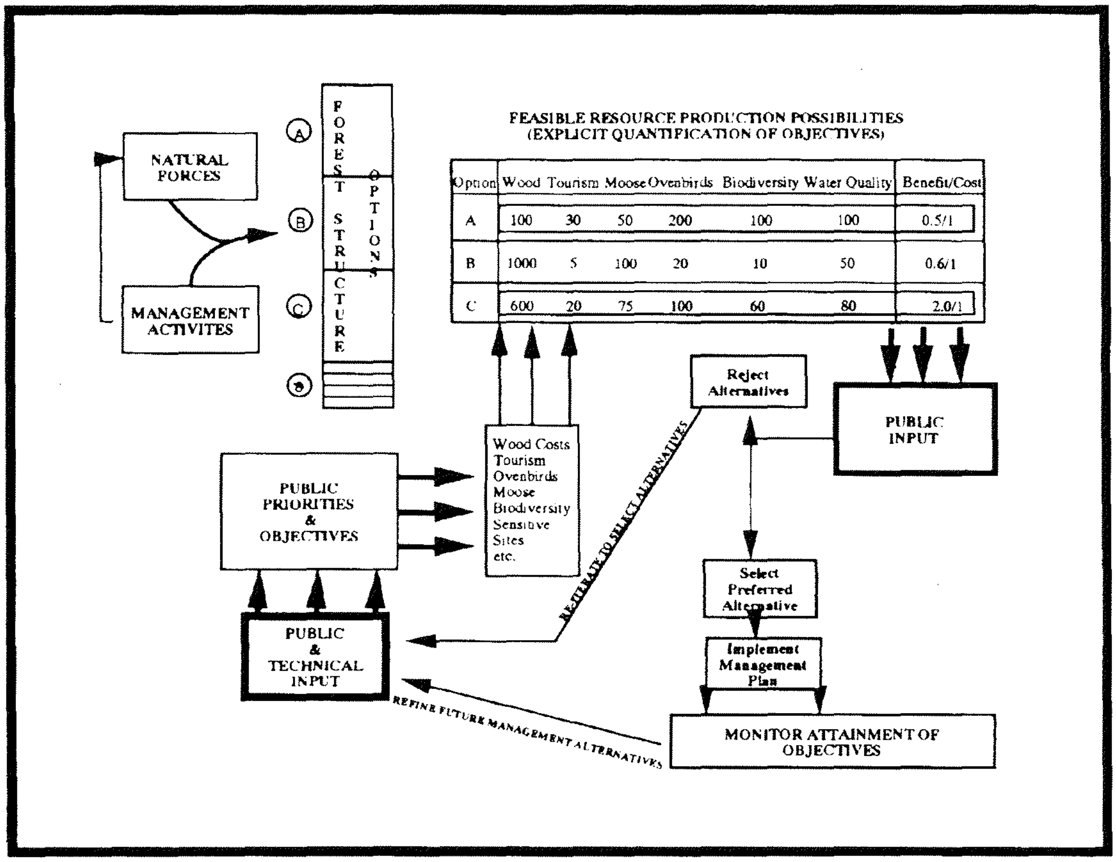

Figure 3. Integrated management and adaptive management.

then forest structures must be put together that reflect those values.

The Saskatchewan Forest Habitat Project deals only with a few species of wildlife. The species were selected on the basis of trying to maintain a diverse forest structure wherein timber harvesting would occur. Specific objectives have not been established during the two and one-half years of the project. There is tremendous reluctance by industry to establish objectives for timber. Government on the other hand is reluctant to establish objectives for wildlife. Both sides are delaying the development of the process.

Both sides have to be willing to put their objectives down before integration can take place. Specific problems that are jurisdictional in nature and related to those objectives have to be overcome. Communication problems must be overcome to be able to establish an integrated management plan that will allow the attainment of the goals.

In a fully integrated plan, many resource values must be considered. Watershed protection (i.e., aquatics) is another component, as well as other species of wildlife, tourism and recreation. Tourism and recreation are complex because there are different types. There is wilderness recreation. There is day use. These are all

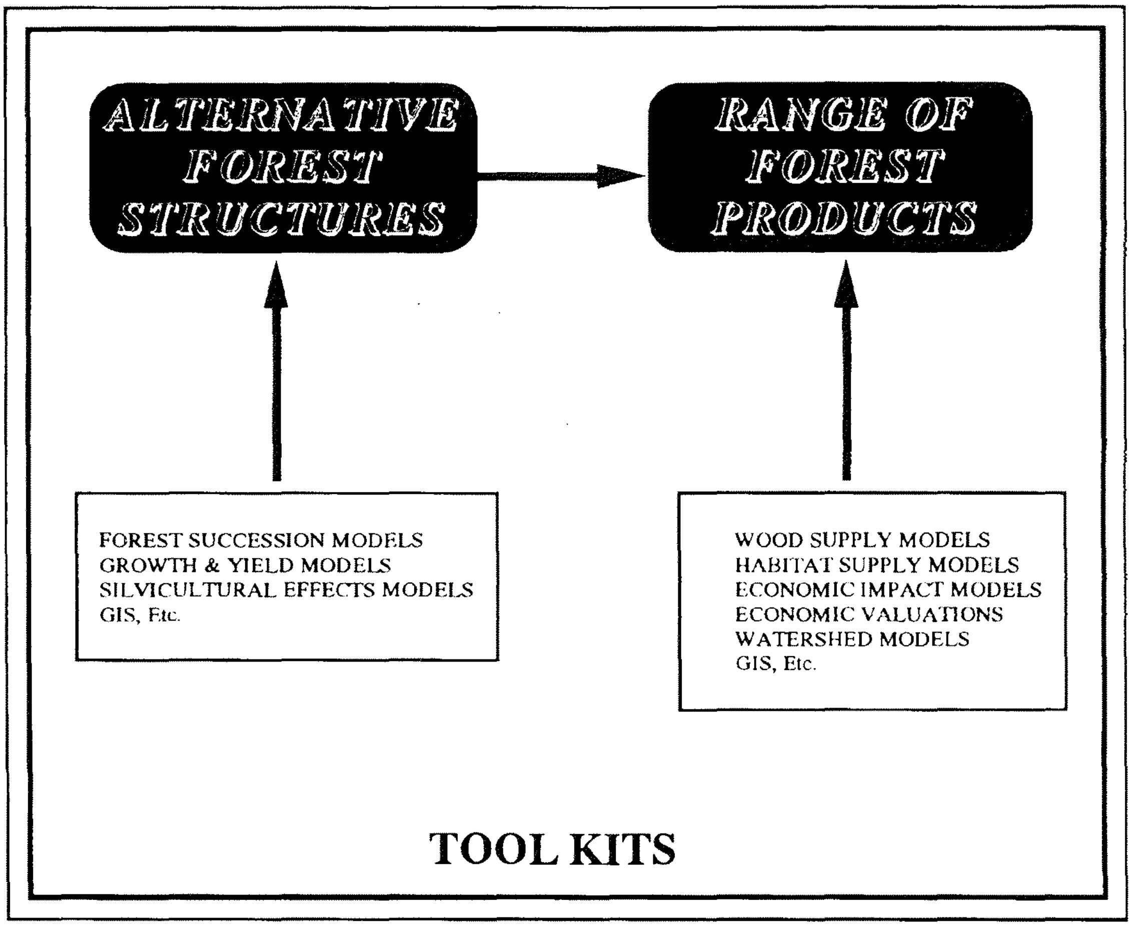

Figure 4. Computer tools necessary to determine forest products supply.

components of expectations people have from the forest. The result of bringing many of the components together is a system that continues and develops the forest structures that will best meet those expectations. This is essentially what the Saskatchewan Forest Habitat Project is trying to do with wildlife.

Saskatchewan lacks a good forest succession model and forest site classification system. It is one of the weaknesses. The people at Weyerhaeuser will be involved in the development of a forest succession model. This model will be the basis of the agreement by both parties to establish objectives and measurements for the future.

Growth and yield models are also being developed. Silviculture models have been developed at various places across the country. Choices in wood supply models are available. The decision has not been made as to which choice is best for the Saskatchewan forest inventory.

There are plenty of habitat supply models available for many species. There should be enough information on those species already, so that habitat supply models will be readily available.

The computer tools necessary to determine forest product supply (Figure 4) are available as economic impact models, growth and yield models, and watershed models, to name a few. There is a structured framework within which we want to operate, and are going to operate. People and organizations with specific interests related to species of wildlife are starting work with the planning teams on putting together the integrated resource management plans that will define Saskatchewan during the next 20 years.

DISCUSSION

Comment by Mr. Bonar: I agree with you, Bob, when you were talking about the need to set specific objectives for both wildlife and timber. I'd submit that the reason we haven't been able to do that yet is partly because we don't have the detailed information that we need to set those wildlife objectives. I guess we're in the same boat in Weldwood. The problem we have is that we can sit down with Fish and Wildlife, for example, and translate the present objective for single species into something that we might be able to integrate. The present objective is that the Fish and Wildlife division wants to double the elk population by the year 2000. We don't know if that is a feasible option. We don't have information on elk habitat and elk numbers that we'd be able to plug into our timber supply and wildlife habitat models that would say that that is a reasonable option. We need to have the tools in place and the information to feed into it, before we can develop those specific objectives.

Response by Mr. Stewart: I agree. This is top-down, deterministic mode of government that says we're going to have 10 000 elk on the land base and that is our objective. But they haven't gone out on the land base to determine if you have the habitat to support that, or if we can manipulate the habitat to support that. They're pushed down onto the land base, and we're forcing the land to try to meet objectives that may not be feasible in either time space or habitat.

We must develop the connections between habitat and wildlife. Failure to do this is one of the major problems that we face. Now, there are ways that we can integrate. There are reasonable numbers of elk that we believe are out there, based on our existing knowledge of elk habitat analysis. Let's start working with it and find out. There are defined relationships between habitat and elk numbers that have been worked out in other areas.

Let's modify those for the Weldwood area, and let's find out if we can support that many elk. If we can't, the objective should be coming up from the bottom and then back down. You can't define population objectives unless you have a habitat base to support it, and there are other components to that.

People might not want 10 000 elk. They might want 5 000 moose and 2 000 elk. Who is making the decision? We have to get the public involved at the grass-roots level of the process to assist us in making those decisions at the local level.

Comment by Ms. Cumming: There is one thing you were mentioning: We have to start somewhere. The comment was that this isn't really complicated because it is not rocket science. I suggest that ecosystems are extremely complicated. If we had all the rocket scientists in the world and got them together in one room, I don't think they'd know how to fix a damaged ecosystem. If there was an extinct species, they couldn't bring it back.

Response by Mr. Stewart: There is no doubt that ecosystems are extremely complex, but the interventions that we have in ecosystems are ones that we can measure. If we're going out and changing forest structures, we know that we are going to have impacts on compaction of soils. We are going to have impacts on erosion. We haven't studied every element about water quality. Let's focus our attention on things that we know that we are impacting upon, and take a cautious step forward.

We manage with uncertainty. The greater the uncertainty, the more conservative the approach we take. If we know a lot about what we're doing, we can be more liberal in our thinking, and the approach that we take in designing a management plan. You have to build the uncertainty in the system, and express in explicit terms that we know where the uncertainty exists. Therefore, we take a conservative approach. There are more complex components in my model than what I have given here in 15 minutes. They are built-in.

With the issue of extinction, it is your job to put your best knowledge together as a group of people to tell forest managers exactly what kinds of forest structures those birds that you're interested in require; what the similarities are in forest structures; to give us guidance to go on, and design management plans. If you don't do that, we're going to manage the forest without you. That is what I'm saying.

Response by Ms. Cumming: I realize we all have to work together, and there are measurable parameters. I was just taking exception to that comment. That is what I had to say.

Comment by Mr. Lyle: I'm here representing the Farm Woodlot Association. I don't really have a question for Bob. I think his presentation was great, and I'm glad he mentioned the public. I consider myself a representative of the public voice, and I think the public is the reason that everybody is here right now. I would like to have two minutes to give my overview of this whole conference.

Last night I went to the brainstorming session hoping to find some answers to what this whole conference was about. What I saw was closer to a storm without a brain that would guide things, and I found it very frustrating. I know there are a lot of industry representatives here. Other people like myself came here expecting something a little different, hoping to find some answers to some of our questions. All we've got is the frustration of all these people here as to what direction to take. I think if they take a big step back, and go look at what the public is demanding of them, they have to start there on the ground. All this talk about fragmentation, the most fragmented thing I've seen so far is the different views and opinions of the people here. I see that as far more negative than what is happening in the forest right now. We have to get focused.

What I want to know and what most of the members of the Woodlot Association who are interested in birds want to know is first, what purpose these birds have in the general overview of the ecosystem. How do they interact? How important are they? Some are more important than others as far as how we're impacted. The most important birds have to be concentrated on initially, to reduce the impact or the potential negative impact of forestry operations.

In all the bird literature I read, the most striking thing is how little is known about most of these birds. They don't even know where they go in the winter because their numbers are depleted and they're hard to follow. They don't even know what they eat. They might have a slight idea of what they eat, but they don't know how that interacts with the rest of the ecosystem.

We are part of the ecosystem too. Until we can understand how these different animals interact with it and how we affect these animals that help to keep things under control out there, we don't know where our place in the ecosystem is. The public has a growing sense of urgency to find out these questions, get some answers to these questions. I see all these people going off in different tangents without a concerted focused effort to find out what is going on. One area of research that I think should be concentrated on more than guessing at what is going on in the forest and its impact is to find out where these birds stand in ordinance in the ecological community. My general view is when you look at the birds and the forest as two separate entities, you have a distorted perspective of things right away. Unless you look at them as a single whole with us included, you're going to run into problems of where to focus your attention.

There are birders, people who are interested in them for the love of them. They're directly affected by just the song of a bird, more important than being able to buy a tag for hunting or whatever.

I consider as a very basic thing that the birds are the forest, and the forest are the birds. They are both me. If we approach our research needs with that overall perspective, I think we have a good chance of not wasting our time and our money starting in the clouds, and working down, and hoping we're doing something right. I'd like to see the focal point start on the ground and work its way up.

THE ALBERTA VEGETATION INVENTORY - FROM THE GROUND UP

Tom Lakusta
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ABSTRACT

The Alberta Vegetation Inventory was developed to address the needs of non-timber land management groups as well as the expanding needs of the forestry community, particularly with respect to the deciduous resource. The specifications of the Alberta Vegetation Inventory are presented and discussed. Identification of differentiable overstorey layers and any understoreys are key elements in the inventory. The inventory began in 1987, with 754 townships, mostly along the agriculture/forestry fringe, completed to date.

Alberta's new reforestation standards complement the Alberta Vegetation Inventory. Alberta has had reforestation standards since 1966 that ensured all cutblocks were adequately stocked with established seedlings. A project initiated in 1985 to re-check older cutblocks indicated that, although adequately stocked, many did not contain vigorously growing crop trees. A new set of reforestation standards were developed that addressed performance objectives as well as the former establishment objectives. The Free-To-Grow standards will ensure that every cutblock harvested since March 1, 1991 is adequately stocked and free-growing by the fourteenth year after harvest.

INTRODUCTION

Most presenters in the last few days have provided expert opinion on a variety of issues. My presentation will relay information about the new Free To Grow (FTG) reforestation standards that were implemented last year to round out the latest developments in forest management in Alberta.

INVENTORY HISTORY

The Alberta government has been conducting forest inventories since 1949. These inventories were initially designed to identify timber of sufficient piece size and extent for lumber production. They also gave rough approximations of growing stock. A more detailed forest inventory suitable for planning sustained yield management was required by 1970. This new inventory was called Phase 3. It included rough interpretations of understorys and some generalized non-forest classifications but was not a complete vegetation inventory.

BACKGROUND TO THE ALBERTA VEGETATION INVENTORY

The Alberta Forest Service saw the need for a new inventory even before the completion of the Phase 3 in 1985. One of the major needs was to better understand the deciduous resource. Phase 3 concentrated on the coniferous land base. Senior management made it clear that there could be no new inventory initiatives unless an integrated vegetation inventory that addressed the needs of other land management groups was the result. A Vegetation Technical Committee was formed to develop the specifications. The committee was composed of foresters, range managers and a wildlife biologist. The committee developed the specifications that are being used today, though there have been modifications to maximize their clarity mainly for timber quantification.

SPECIFICATIONS OF THE ALBERTA VEGETATION INVENTORY

As a foundation, the Alberta Vegetation Inventory (AVI) is based on a 1:20 000 scale photo-interpreted spatial database. The classification choices available to the interpreter are keyed in Figure 1. The Natural Class found near the top of the key under Land Area; Vegetated; Natural, is broken into forest and non-forest groups. As an example the shrubland is by definition deciduous. The height of the shrub layer is estimated by the photo-interpreter to the closest metre. The percent of crown closure for open shrub layers is estimated in 10% classes. A moisture regime modifier is assigned at this point as well.

If forested, the classification requires:

- crown closure (4 classes)
- height of codominants, estimated to the nearest metre
- species composition, in 10% classes
- year of origin, in 10 year classes
- stand condition modifiers, and
- a timber productivity rating

The stand structure is probably one of the more key elements in habitat assessments. In a typical even-aged stand there will be one overstorey label and where one exists, an understorey label using the same specifications as the overstorey. Interpreters are instructed to label understoreys only where they can be seen. No guessing.

A stand with two differentiable overstorey layers is called a horizontal structure. This stand would have, for example, clumps of spruce and clumps of aspen, but the clumps are too small to form a polygon because of cartographic scale limitations. This is unlike a mixedwood stand where spruce and aspen trees grow next to each other. Both overstoreys and any existing understorey are fully labelled. The percent representation each overstorey is of the polygon (Figure 2) is added to the labels.

Stands with three or more vertical layers are considered complex stands. They are given full labels that include the mid-point and ranges of overstorey heights and any existing understoreys.

Modifiers

All vegetated polygons are given a moisture regime modifier that ranges from dry to aquatic (Figure 2). There are also many stand condition and silvicultural treatment modifiers (Figure 2). Clear-cut, windfall, snags and broken tops are examples of stand condition modifiers. All stand modifiers also come with an extent attribute that ranges from light to severe. For example, a snag density of 5-199 snags per hectare is considered moderate in extent.

Mapping

The AVI map legend is presented in Figure 3. There is a great deal of flexibility in choosing what to represent on maps because the AVI is a digitized inventory that is easily accessible through geographic information system (GIS) software. Some details on minimum polygon sizing and the process and costing of the inventory are shown in Figure 4.

AVI coverage

This is the third year of continuous inventory. To date, 754 townships have been completed since 1987 when the inventory began. Most of the coverage is along the agriculture/forestry fringe (Figure 5) where the greatest need for the inventory exists. We are also using the AVI to replace Phase 3 inventory as the need arises for timber quantification.

The inventory is continually updated with new information related to harvesting and other disturbances to keep the inventory current. Reforestation standards come into the picture here.

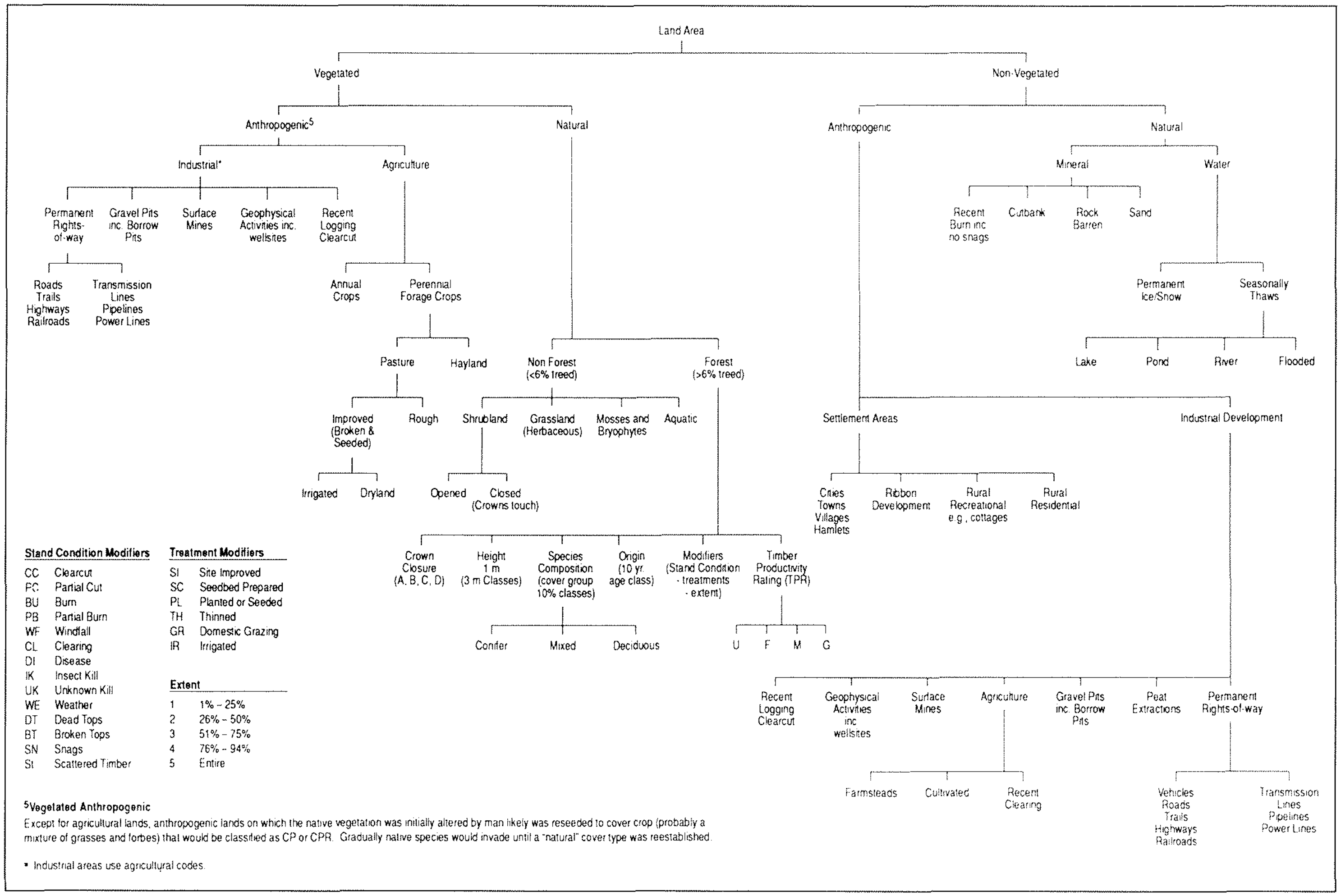

Figure 1. Alberta Vegetation Inventory - Primary Classification.

AVI INTERPRETATION LEGEND

VEGETATED LAND

FOREST LAND

LAND SUPPORTING TREE COVER INCLUDES SEEDLINGS AND SAPLINGS WITH A CROWN CLOSURE OF ≥ 6% OF TREE SPECIES (SEE BELOW)

STAND ATTRIBUTE DESCRIPTIONS

BASIC - SINGLE STOREY

Moisture Regime Modifier
Crown Closure Class
Height
Species Composition

wB21Sw10 87-M

Site Class
Origin Class
% of Species in Stand

MAXIMUM ATTRIBUTE - SINGLE STOREY

Disturbance
Severity
Disturbance
Severity

wB245Sw5Aw2Pb1P1Fb1-Y1-X2-T-f 95-G

Field Checked
Stand Condition

BASIC - TWO-STOREY

OVERSTOREY

wB17P10 87-M / wB13Sb10 90-M

UNDERSTOREY

MAXIMUM ATTRIBUTE - TWO-STOREY

HORIZONTAL STRUCTURE

wB16Sw3Sb3L12P1Fb1-Y1-X2-H7-1 92-G / wD8Sb7P3-H3-f 85-G

Must combine to 100% of Stand Area

A MINIMUM OF A 3 METRE DIFFERENCE IN HEIGHT MUST OCCUR BETWEEN THE OVERSTOREY AND UNDERSTORY BEFORE A STAND IS IDENTIFIED AS - "TWO-STOREY" - (DOES NOT APPLY TO STANDS WITH HORIZONTAL STRUCTURE)

MOISTURE REGIME MODIFIERS

APPLIES TO ALL VEGETATED LAND COVER TYPES

MODIFIER	CODE
Upland Undifferentiated	u
Upland Dry	d
Upland Mesic	m
Wet	w
Aquatic	a

CROWN CLOSURE

PERCENTAGE OF GROUND AREA COVERED BY A VERTICAL PROJECTION OF CROWNS INTO GROUND

CROWN CLOSURE (%)	CODE
6 - 30	A
31 - 60	B
61 - 70	C
71 -100	D

HEIGHT

STAND HEIGHT IS THE AVERAGE OF ONLY THE DOMINANT AND CO-DOMINANT TREES. ALL SPECIES AND IS ESTIMATED TO THE NEAREST METRE. ADJACENT STANDS SEPARATED ON THE BASIS OF HEIGHT ALONE MUST HAVE A HEIGHT DIFFERENCE OF GREATER THAN 3M.

Figure 2. Alberta Vegetation Inventory interpretation legend.

SPECIES COMPOSITION

STAND COMPOSITION LISTS SPECIES (TO A MAXIMUM OF 5) IN DECREASING ORDER BASED ON CROWN CLOSURE. THE PERCENTAGE OF EACH SPECIES IS INDICATED TO THE NEAREST 10% WITH A SUBSCRIPT. THE SUBSCRIPTS MUST ADD UP TO 10 (i.e., 100%)

TREE SPECIES	CODE
White spruce	Sw
Englemann spruce	Sw
Black spruce	Sb
Lodgepole pine	P
Jack pine	P
Whitebark pine	P
Lumber pine	P
Balsam fir	Fb
Alpine	Fb

TREE SPECIES	CODE
Douglas fir	Fd
Western larch	Lt
Eastern larch	Lt
Alpine larch	Lt
Trembling aspen	Aw
Balsam poplar	Pb
Paper (white) birch	Bw
Populus species (Undifferentiated)	A

DISTURBANCES

DISTURBANCE FACTOR	CODE
Disease	V
Weather (e.g., wind redbelt)	W
Partial cut	X
Partial burn	Y
Insect	Z

DISTURBANCE SEVERITY	CODE
Light - 1-25% Loss	1
Moderate - 26-50% Loss	2
Heavy - 51-75% Loss	3
Severe - 76 + % Loss	4

CONDITION

CONDITION	CODE
Site improved (amelioration)	A
Seedbed prepared (Bed)	B
Planted and/or seeded (Planted)	P
Thinned (density control)	D
Stagnant (stagnant)	S
Terminating (Terminating)	T
Developed for Grazing (Grazing)	G

STAND STRUCTURE

STRUCTURE	CODE
Complex	C

- NO DISCRETE LAYERS VISIBLE OR MOSAIC PATTERN OF VARYING HEIGHTS, ALSO WHEN MANY LAYERS (INTERMIXED) PRESENT. 3 M HEIGHT DIFFERENCE MUST BE PRESENT BETWEEN EACH STRUCTURE

Horizontal	H

- HORIZONTAL RELATIONSHIP BETWEEN THE SUBSTANDS INSTEAD OF A TWO-STOREY OR COMPLEX STRUCTURE. 3 M HEIGHT DIFFERENCE IS NOT REQUIRED BETWEEN EACH STRUCTURE

FIELD CHECKED

WHEN ALL ATTRIBUTES WITHIN A FOREST STAND DESCRIPTION HAVE BEEN CONFIRMED THROUGH INTERPRETER FIELD CHECKING. THE CODE - 1 - 15 IS LABELLED IN THE STAND DESCRIPTION.

ORIGIN

BIRTH YEAR (10 YEAR INTERVALS)	CODE
1960-69	96
1970-79	97
1960-69	96

FOREST SITE CLASS

CLASS	CODE
Good	G
Medium	M
Fair	F
Unproductive	U

Figure 2. Alberta Vegetation Inventory interpretation legend (continued).

SCALE 1 : 20 000

1000 m 500 0 .5 1 2 km

MAP LABEL LEGEND

PRODUCTIVE FOREST LAND

FOREST STAND DESCRIPTIONS

BASIC LABEL

Crown Closure Class
Height
Cover group
Leading Species
B6CD-Sw
92
Origin Class

MAXIMUM LABEL

Modifier
Modifier
Stand
Structure
B6CD-Sw-PC-BU-C
92

MAXIMUM LABEL
HORIZONTAL STRUCTURE

B6CD-Sw-PC-BU-7
92
B5CD-Sb-3
93
Must Combine
to 100% of
Stand Area

CROWN CLOSURE

CROWN CLOSURE (%)	CODE
6 - 30	A
31 - 60	B
61 - 70	C
71 -100	D

HEIGHT (consistent with volume strata)

AVERAGE HEIGHT (M)	CODE
0 - 12	0
13 - 15	4
16 - 18	5
19 - 21	6
22 - 25	7
over 25	8

COVER GROUP

(consistent with volume strata)

COVER GROUP	CODE
coniferous	C
coniferous-deciduous	CD

COVER GROUP

	CODE
Deciduous	D
Deciduous-coniferous	DC

Figure 3. Alberta Vegetation Inventory map label legend.

LEADING SPECIES

(As Taken From CVI Interpretation Call)

TREE SPECIES	CODE
White spruce	Sw
Englemann spruce	Sw
Black spruce	Sb
Lodgepole pine	P
Jack pine	P
Whitebark pine	P
Lumber pine	P
Balsam fir	Fb
Alpine fir	Fb
Douglas fir	Fd
Western larch	Lt
Eastern larch	Lt
Alpine larch	Lt
Trembling aspen	Aw
Balsam poplar	Pb
Paper (white) birch	Bw
Populus species (undifferentiated)	A

NON-VEGETATED LAND

Cleared land	Clo
Cultivated land	Cult
Cutbank	CB
Flooded	FL

NON-FOREST LAND

Vegetated covertypes with ≥ 6% plan cover but 6% tree cover

CLASSIFICATIONS	CODE
Closed shrub (crowns interlocking)	SC
Open shrub (crowns not touching)	SO
Herbaceous (Grassland)	HG
Herbaceous (Forest)	HF
Bryophyte (mosses and or Bryophytes)	BR

Shrub Height and Crown Closure	CODE
Height descriptors of 1-6 m (applies only to shrub cover)	1-6
Percentage of shrub crown closure (with polygon and, indicated to the nearest 10% by a subscript)	1-10

STAND MODIFIERS

MODIFIERS	CODE
Burn	Bu
Clear-cut	CC
Partial cut	PC

STAND STRUCTURE

STRUCTURE	CODE
Complex	C
Horizontal (% in layer)	H

ORIGIN

BIRTH YEAR (10 year intervals)	CODE
1980-89	98
1970-79	97
1960-69	96
ETC	ETC

Rock Barren	
Sand	SA
Water	W

MODIFIERS	CODE
Clear-cut	CC
Partial cut	PC
Irrigated	IR
Burn	BU
Windfall	WF
Clearing	CL
Disease/Insect Kill	IK
Unknown fill	UK

A site index G, M, D, or U if known is applied to all non-forest covertypes. This may be derived from similar adjacent areas. The date of the modifier, if known is also shown e.g., m3SC, (CC-1951-M)

These classifications and modifiers may be used in conjunction with Forest Lands when described in a horizontal (H) type of structure, or a standard two storey stand.

ANTHROPOGENIC VEGETATED LAND

COVERTYPES THAT HAVE BEEN INFLUENCED BY MAN, USUALLY AREAS THAT HAVE BEEN PLANTED WITH CULTIVATED SPECIES (i.e., CROPS IN FIELDS)

Figure 3. Alberta Vegetation Inventory map label legend (continued).

AGRICULTURE	CODE
Annual crops	CA
Perennial Forage Crops	CP

AGRICULTURE	CODE
Hayland	CPH
Improved Pasture	CPI
Rough Pasture	CPR

THESE CATEGORIES MAY BE USED IN CONJUNCTION WITH OTHER VEGETATED AND NON-VEGETATED LANDS AS HORIZONTAL STRUCTURES.

NON-VEGETATED LAND

ANTHROPOGENIC NON-VEGETATED LAND

COVERTYPES CREATED BY MAN WITH <6% PLANT COVER

SETTLEMENT AREAS	CODE
Cities, Towns, Villages & Hamlets	ASC
Ribbon Development, Rural & Recreation (i.e., Rural stores, isolated housing subdivisions, cottages, rural residential acreage owners)	ASR

Agriculture is not the primary income source

INDUSTRIAL DEVELOPMENT	CODE
Permanent right of ways (i.e., airstrips, microwave towers sites etc.)	AIP
Peat extractions	AIE
Gravel Pits I/C borrow pits	AIG
Farmsteads (Agriculture)	AIF
Cultivated (Agriculture)	AIC
Recent Clearing Agriculture	AIR
Surface Mines	AIM
Geophysical Activities I/C well sites	AIW
Recent logging, clear-cut	AIL
Industrial sites	AII

NATURALLY NON-VEGETATED LAND

NATURAL COVERTYPES THAT HAVE < 6% PLANT COVER

WATER	CODE
Permanent Ice/Snow	NWI
Seasonal Thaws Lakes & Ponds	NWL
River	NWR
Flooded (areas periodically inundated with water)	NWF

MINERAL	CODE
Recent Burn I/C Number of Snags (To date no recovery of vegetation)	NMB
Cutbank	NMC
Rock Barren	NMR
Sand	NMS

THE ABOVE NON-VEGETATED LANDS MAY ALSO BE USED IN A HORIZONTAL STRUCTURE WITH VEGETATED LANDS

GEOADMINISTRATIVE BOUNDARIES & SYMBOLOGY

Integrated resource Plan (IRP)
Eastern Slopes Integrated Planning Area (ESIP)
Patented Land Wilderness Area
Natural Area
A.F.S. Recreation Area (FRA)
Parks Recreation Area (PPR)
Grazing Reserve
Ecological Reserve
Photogrammetric Control Point

Inventory Boundary
Forest Reserve
Forest Boundary
Forest Management Unit
Forest Management Agreement Area (FMA)
Quota Area
Provisional Reserves
Miscellaneous Timber Use Area
Community Farm Woodlot
Experimental Forest

Orthophoto an Digital Base Photography — Date: 1982 Scale: 1:60,000
Vegetation Interpretation Photography — Date: 1987 Scale: 1:20,000

Figure 3. Alberta Vegetation Inventory map label legend (continued).

Vegetation Interpretation Performed by: Stewart & Ewing Associates Ltd.

Map Production Date: 1991 Revisions:

For more information concerning legend see "Alberta Vegetation Inventory - Photo Interpretation Procedures and Technical Specifications" Manual.

Produced by Land Information Services Division for

Alberta Forest Service
Fish and Wildlife Division
Public Land Division

Figure 3. Alberta Vegetation Inventory map label legend (continued).

REFORESTATION STANDARDS - BACKGROUND

Reforestation standards between 1966 and 1989 ensured that cutblocks were at least 80% stocked by the tenth year following harvest. These standards were effective as an average of 96% of all cutblocks were satisfactorily stocked after 10 years.

During this period, however, a rising tide of anecdotal information suggested that many "satisfactorily stocked" stands were not growing vigorously. The Juvenile Stand Survey (JSS) conducted in 1985-86 re-surveyed 318 coniferous cutblocks 12 to 20 years old in an effort to confirm and quantify these suspicions.

The results of the JSS showed that seedlings were not growing at the expected rate mainly because of vegetative competition from Aspen and *Calamagrostis*. Small mammals (Bunnies) that eat the buds and needles of young seedlings are another factor in retarding growth. The results of the JSS showed that because of the ABCs of coniferous reforestation:

1. 38% of the re-surveyed cutblocks that had passed the establishment standards were no longer satisfactorily stocked and;

2. an additional 20% were stocked with undesirable hardwoods.

The JSS clearly indicated the need for new reforestation standards to ensure that reforestation efforts result in vigorous growth of new forests that will yield a merchantable crop.

THE FREE TO GROW STANDARDS

The are two parts to the new standards. The first is a check-off of adequate stocking. The second part is the new check-off to ensure free-growing vigorous seedlings.

Cutblocks must be initially assessed for regeneration needs. They must be treated in accordance with those needs within two years following harvest. Coniferous cutblocks are surveyed four to eight years following harvest (3-5 years for deciduous cutblocks) to determine if they meet the requirements of the first check-off (Figure 6 and Figure 7). Cutblocks are re-treated and resurveyed until this standard is met.

A performance assessment for the second check-off is made before the 14th year following harvest. Seedlings must stock 80% of the sample plots in a cutblock in accordance with the standards (Figure 8). The saplings have to meet the stocking and height requirements but must also be unimpeded by competing vegetation. Roughly, this means that the saplings must be one-third taller than competing vegetation growing within one meter of the saplings. The saplings in the stocked plots are referred to as crop trees. Establishment standards for mixedwood cutblocks are similar.

Minimum Polygon Size Summary

20 hectares	-	if there is a minor difference in classification
	e.g.	the understory or second stand layer changes by a density, height, or origin class
10 hectares	-	if there is a meaningful difference in classification
	e.g.	the species composition of the overstorey changes, but all else remains constant
2 hectares	-	for major changes in vegetation
	e.g.	forested and non-forested patches
Minimum polygon width:		20 meters for most applications.

Poly Specifications/Process and Costings

Scale: 1:20,000 (township is lowest block level)

Film:
- primarily using Agfa 200 B/W
- have also used Kodak 2424 B/W IR
- processing to tolerances for maximum contrast

Process:
1. fly 1:20,000 Agfa 200 B/W
2. orthophoto base created using existing 1:60,000 photos to position township base most accurately;
3. use 1:60,000 to broadly stratify vegetation origin classes;
4. interpret 1:20,000 photos
5. transfer to orthophoto base;
6. digitize;
7. Audit: - interpretation - transfer/coding/digitization

Cost:
- much of work done by private sector through contracts;
- completed total cost approximately $5000/township

Map Product: Map output is still evolving. Standard products are available for all townships. GIS driven attribute comparison are also being done as requested as custom outputs.

Completed:
1987-65 townships (pilot)
1989-90 - 591 townships
1991-98 townships
1992-97 townships (projected)

Miscellaneous: Base mapping is also being done by a different agency. These highly controlled base maps are done to NAD27, accurate within 5 meters. Approximately cost is $5000/township.

Figure 4. Polygon size summary, processes and costings for the Alberta Vegetation Inventory.

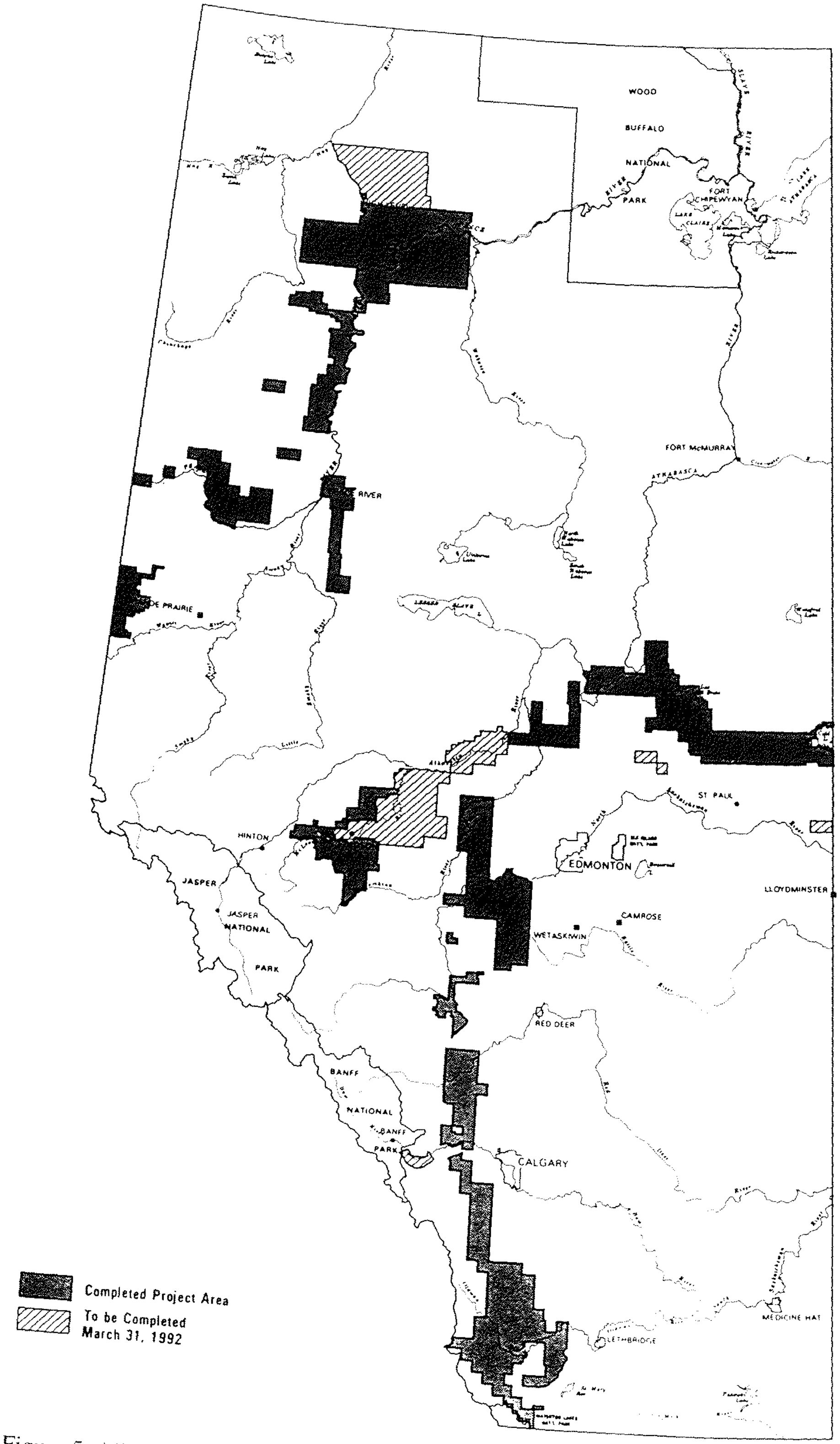

Figure 5. Alberta Vegetation Inventory project area to November 1991.

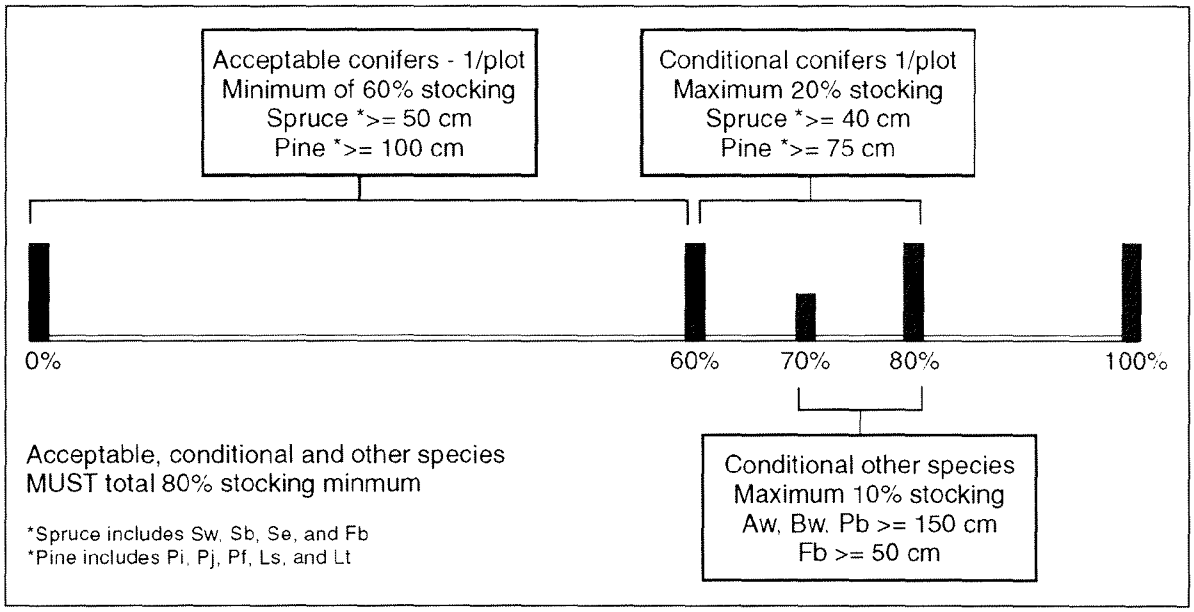

Figure 6. Coniferous establishment survey.

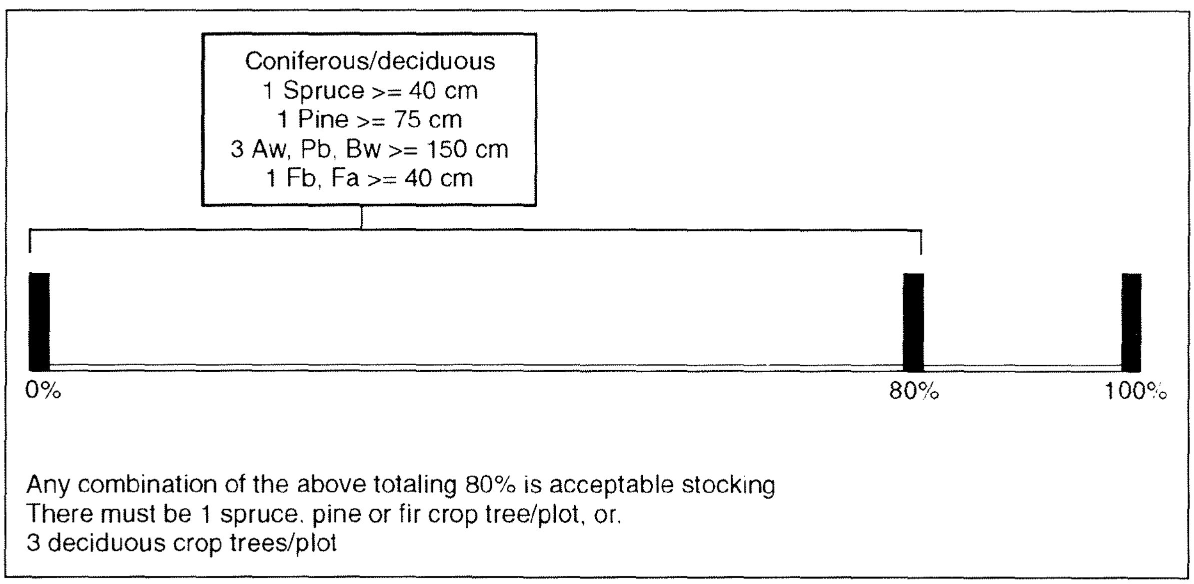

Figure 7. Deciduous establishment survey.

CONCLUDING REMARKS

Much of Alberta's productive timberlands are within Forest Management Agreement (FMA) areas. The FMAs are area-based agreements between the Crown and forest products companies. Agreement holders are required to conduct their own forest inventories to the AVI specifications. Much of these areas will be covered by inventories similar to the AVI in the years to come.

The AVI specifications are not written in stone. Wildlife biologists or ornithologists are more than welcome to seek the integration of certain habitat characteristics they feel are necessary with the current AVI specifications.

The Alberta Forest Service received approval through an Order-In-Council on March 1, 1991 to establish the new Free to Grow reforestation standards in the operational Timber Management Regulations.

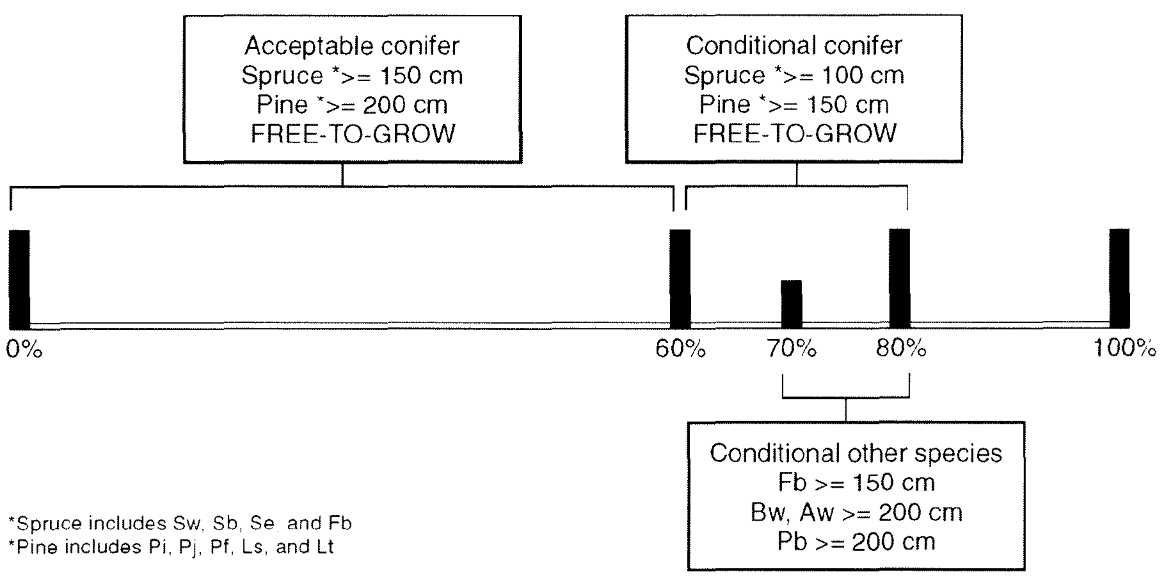

Figure 8. Coniferous performance survey and check-off.

DISCUSSION

Question by Mr. Thompson: Alberta's one of the few provinces that's blessed with a forest ecological classification. I was wondering whether you're going to incorporate it into your system, or whether you've given any thought to using it at all.

Response by Mr. Lakusta: Yes, we've given quite a bit of thought to using it. The ecoregions of Alberta were created by Strong and Leggat back in '81 have been looked at again. Wayne Strong has done another good job with it. We've got much tighter boundaries, and we've also added ecodistricts to the classification. Now, it isn't married to the Alberta Vegetation Inventory in that the polygon boundaries are by definition going to be the same. It isn't a hierarchal stratification, but we will be using that. From a timber perspective we'll be looking at using the ecoregions (maybe not the ecodistricts, but the ecoregions for sure in requantifying our timber resource). We think there are productivity differences that we can grab onto. I can't speak for the wildlife people in Alberta.

Question by Mr. Thompson: I was thinking specifically of a link between this classification system and the MBC type. Have you made any attempt to convert one to the other?

Response by Mr. Lakusta: I haven't because we found that in the past ecosites developed by Corns (Forestry Canada) and now the ones we have from Sivak (Alberta Forest Service) in southern Alberta appear to have very poor relationships with site productivity. They don't appear to be good driving variables. They are good descriptions of the site and they have a lot of silvicultural utility, but they don't have a lot for quantitative assessments.

Comment by Mr. Bonar: There is a proposal under the new agreement in Alberta to extend the ecosystem classifications that cover portions of the province through the entire forested area of the province. There's also an operational trial (the NAIA Project), which is sponsored by the Alberta Research Council. It takes a forest cover inventory, a soils inventory, and a physiographic inventory, and generates an ecological map using the existing classification and using expert systems. That project offers the tie that you're talking about between ecosystem classifications and the Alberta Vegetation Inventory.

Response by Mr. Lakusta: We have a variety of themes and levels of information that we can use underneath the AVI. At this point it hasn't been attempted.

OPPORTUNITIES AND GOALS OF THE NEOTROPICAL MIGRATORY BIRD CONSERVATION PROGRAM - PARTNERS IN FLIGHT

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ABSTRACT

In the fall of 1990, a major program for the conservation of migratory landbirds that breed in North America and winter in Latin America and the Caribbean Basin was initiated. Numerous federal, state, and private organizations in the United States endorsed the initiative by signing an official agreement to cooperatively conserve populations of neotropical migratory birds. These include the U.S. Fish and Wildlife Service, the U.S. Forest Service, Bureau of Land Management, National Park Service, Agency for International Development, Department of Defense, National Audubon Society, The Wildlife Management Institute, The Wildlife Society, International Council for Bird Preservation, and many more. Working groups for Information and Education, Research, Monitoring, International Affairs, Legislation, and Regional Management have been established to implement the program. To expand the program internationally, participation by Canadian, Latin American, and Caribbean governmental and nongovernmental organizations is sought.

INTRODUCTION

The Neotropical Migratory Bird Conservation Program was established in the United States two years ago by numerous partners in state and federal government agencies and in the private sector. To effectively protect neotropical migratory birds and their full range of habitats, however, the program must transcend American boundaries. Neotropical migratory birds are a resource shared by Latin American and North American countries, and therefore, their conservation is dependent on cooperation and coordination among all Western Hemisphere countries in which they are found. The interest in coming to this Canadian workshop on birds in the boreal forest was to inform likely international partners like Canadian Wildlife Service and Forestry Canada about the goals and opportunities of this program.

The Neotropical Migratory Bird Conservation Program is a strategy to conserve and recover neotropical migratory birds and their habitats throughout the Western Hemisphere. The motto for the program is "Partners in Flight - Aves de las Americas". The logo depicts a stylized neotropical migratory bird species, the American redstart. The program was initiated in the fall of 1990, in response to a proposal by the National Fish and Wildlife Foundation (a financial institution established by the United States Congress).

As of May 1992, twelve federal agencies and numerous nongovernmental organizations (NGO) have formalized their support of the Partners in Flight program by signing a Memorandum of Agreement. Federal agencies include: the U.S. Fish and Wildlife Service, U.S. Forest Service, Bureau of Land Management, National Park Service, U.S. Agency for International Development, Department of Defense (Navy, Army and Air Force), Environmental Protection Agency, Soil Conservation Service, APHIS Animal Damage Control, and U.S. Department of Agriculture Cooperative Extension Service. The NGO signatories so far include: The Wildlife Society, American Forest Resource Alliance, American

Ornithologists' Union, Conservation International, The Nature Conservancy, Cornell Laboratory of Ornithology, National Audubon Society, The Nature Conservancy, World Wildlife Fund, Institute for Bird Populations, The Wildlife Management Institute, Hawk Mountain Sanctuary Association, International Association of Fish and Wildlife Agencies, International Council for Bird Preservation, Manomet Bird Observatory, Point Reyes Bird Observatory, and National Fish and Wildlife Foundation.

The National Fish and Wildlife Foundation has used its Challenge Grants Program to jumpstart the program. Funds have also been appropriated in 1991 and 1992 from the U.S. Congress to support research and management projects of the U.S. Fish and Wildlife Service and the U.S. Forest Service. Funding needs for state game and fish agencies and for the U.S. Fish and Wildlife Service's Western Hemisphere Program were highlighted in the fiscal year 1993 Fisheries and Wildlife Assessment of the National Fish and Wildlife Foundation (1992).

WHAT IS A NEOTROPICAL MIGRATORY BIRD?

The Neotropics are defined as the region between the Tropic of Cancer and the Tropic of Capricorn. A neotropical migrant is a bird that migrates within, or to the Neotropics. North American interest in neotropical migrants is related to the fact that many neotropical migrants breed throughout North America. They migrate to Mexico, Central America, South America, and the Caribbean Basin to winter. The winter distributions of neotropical migrants that breed in eastern North America concentrate in southern Mexico, Central America and the Caribbean, and fan out into South America. Breeding birds of western North America winter primarily in western Mexico and Central America.

The Partners in Flight program encompasses neotropical migratory bird species that use forests, shrublands, and grasslands. The program excludes water fowl and most shorebirds. This enables effective focus of funds and energy on those terrestrial migrants experiencing population declines; the majority of which are songbirds. Weatherboards are covered by other major conservation programs like the North American Waterfowl Management Plan and the Western Hemisphere Shorebird Reserve Network. A comprehensive list of neotropical migrants that breed in North America has been developed by Partners in Flight. The list numbers 250 species, including all long-distant migratory landbirds as well as some short-distance migrants that have populations wintering in Latin America.

WHY WAS A SPECIAL PROGRAM NEEDED?

The U.S. Fish and Wildlife Service coordinates a continent-wide bird population monitoring program, called the Breeding Bird Survey (BBS); the results of which are maintained in a centralized data bank. Although these data have been collected over the past 30 years, they were not extensively analyzed until recently. Breeding Bird Survey results showed that over the last 10 years, many neotropical migratory bird species (principally in the eastern United States) have experienced significant population declines. In the west, the trends are less clear, because much of the west has been undersampled by the Breeding Bird Survey. Based on these regional and continental results, biologists recommend that increased efforts in neotropical migratory bird conservation are needed in the east, and increased sampling of bird population trends (e.g., establishment of new BBS routes) is needed in the west.

Trend data from other sources (e.g., Breeding Bird Census - BBC, migration banding stations, radar imagery) plus long term data from many local studies in the Northeast generally corroborate the broad-scale population declines detected by the Breeding Bird Survey. For a thorough literature review of research results and factors leading up to the development of the Neotropical Migratory Bird Conservation Program, see Finch (1991).

What are some of the individual species that are experiencing these population declines? According to both BBS and BBC data, populations of the wood thrush (a fairly common species in the eastern United States and Canada), have declined throughout the Northeast over the last 30 years. Ovenbird, painted bunting, Swainson's thrush, olive-sided flycatcher, and yellow-billed cuckoo are just a few examples of neotropical migratory bird species showing long-term population declines.

Suspected causes of declines include deforestation and forest fragmentation in North and Latin America, contaminants, and the cumulative effects of these factors. Tropical deforestation may contribute to population declines of migratory bird species that winter in areas where blocks of habitat have been eliminated by slash and burn agriculture, pastureland and rural community development, fuelwood harvesting, and timber extraction. Forest fragmentation in North America exposes forest interior neotropical migrants to predators (including domestic pets), cowbird parasites, avian competitors, and human disturbance. Throughout much of the northeast, woodlands and forest tracts have been subdivided by urban development into small isolated parks. These remaining habitat patches are increasingly beset by recreationalists and surrounding urbanization. In the west, forests are fragmented by clear-cutting of timber, other forest management practices, burning, roads, and recreational and urban development. Many ornithologists believe that unrestricted use of pesticides in Latin America is an important factor contributing to population declines. Little baseline data are available to evaluate pesticide effects.

STRUCTURE OF THE PROGRAM

The first annual meeting of the Neotropical Migratory Bird Conservation Program was held December 1990 in Atlanta, Georgia. Meeting participants designed, endorsed, and initiated the program through a consensus process. At the meeting, program plans were developed by topic (research, monitoring, information and education, management, and international affairs) and by two lead agencies (U.S. Fish and Wildlife Service and the U.S. Forest Service).

Two oversight committees were established which represented the signatories to the Memorandum of Agreement. These are committees consisting of representatives from federal agencies and a committee of nongovernment organizations. These two committees meet concurrently twice a year for the purpose of reviewing and guiding program direction.

The heart of the program is implemented by international, national, and regional working groups. National and international working groups address topics in Monitoring, Research, Information and Education, Legislation, International Affairs, and Caribbean Countries. Regional working groups focus on management, conservation, and related issues in the Northeast, Southeast, Midwest, and West. In the United States, new working groups can be established by submitting proposals to the two oversight committees. To foster Canadian participation, a Northern Boreal Forest working group has been suggested. Cooperation and coordination with governments, professional societies, and working groups in other countries are highly encouraged.

GOALS FOR POPULATION AND HABITAT MONITORING

Monitoring of bird populations and their habitats is a major focus of the Partners in Flight program. A Monitoring Needs Assessment has been prepared by the Monitoring Working Group and can be obtained from Greg Butcher, Cornell Laboratory of Ornithology. The Assessment identifies the need to: 1) evaluate, modify, and implement procedures for long-term monitoring of population changes of neotropical migrants on the breeding and wintering grounds; 2) implement long-term monitoring of habitat changes in forests, shrublands, and grasslands; 3) strengthen and standardize current monitoring programs like the Breeding Bird Survey and the Breeding Bird Census; 4) standardize bird count procedures used in research and management; 5) design agency-specific monitoring using standardized protocols; 6) evaluate and incorporate complementary monitoring programs (e.g., Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP)), and 7) design and establish centralized data storage and retrieval centers and systems.

Many National Forests are establishing new BBS routes in roadless areas in an effort to contribute to the need for increased BBS monitoring in the western United States. In addition, the U.S. Forest Service has developed a Monitoring Task Force whose goals are to evaluate and recommend current bird population monitoring procedures for National Forests and Grasslands.

Compatible with the objectives of Partners in Flight are the goals of a relatively new monitoring program called MAPS (Monitoring Avian Productivity and Survivorship). The MAPS program is a constant-effort mistnetting[1] and bird banding program implemented through a continent wide network of stations. It is centrally coordinated by the Institute for Bird Populations (Leader: David DeSante). Primary objectives of the program are to: 1) provide annual regional estimates of bird productivity, recruitment, adult survivorship, and adult population levels; 2) publicize conservation of birds through volunteer participation; and 3) use protected public lands for long-term monitoring efforts. In 1992, 70 MAPS stations were established on public lands. At least 40 were established on private lands throughout the United States. The Forest Service established nine MAPS stations on a trial basis on National Forests in 1992.

GOALS FOR MANAGEMENT

At the first Annual Meeting of the Partners in Flight program December, 1990 in Atlanta, Georgia managers identified the following goals: 1) to identify and conserve habitats essential for declining species; 2) to manage populations and habitats on a sustainable basis; 3) to coordinate management among federal, state and private agencies and organizations; and 4) to manage for biological diversity and viable neotropical migratory bird populations.

The U.S. Forest Service has now developed action plans for each of its nine regions. Action plans in 1992 outline a variety of methods to implement Partners in Flight on National Forests. Included are the following: habitat improvement projects to benefit neotropical migratory birds; public awareness activities like slide shows, posters, and public school projects; cooperative conservation projects with partner organizations like National Audubon Society and The Nature Conservancy; monitoring projects using MAPS and point counts; development of Wildlife Habitat Relationships Models; training of personnel, and identification and protection of critical habitats. By integrating Partners in Flight goals into New Perspectives/Ecosystem Management plans, the Forest Service can increase its ability to sustain biological diversity in managed ecosystems.

GOALS FOR RESEARCH

General Partners in Flight goals for Research are to: 1) determine why neotropical migratory bird populations are declining; 2) verify the species of greatest concern, i.e., those that are most sensitive to changes in habitat; 3) identify the critical resources for maintaining wintering and breeding neotropical migratory

[1] Live capture of small birds using a very fine mesh net.

bird populations; 4) assess ecological and socio-economic impacts of management; 5) develop methods for sustaining and conserving neotropical migratory bird populations; 6) evaluate consequences of land management, including effects of habitat fragmentation due to silvicultural treatments; and 7) transfer research information and technology to land managers and conservationists.

The Research Working Group of the Partners in Flight program has developed a Research Needs Survey which is being summarized and should be available in published form in 1993. The Research Needs Assessment will be circulated to federal, and state agencies, and the private sector. The intention will be to stimulate funding and focus research on high priority topics. The Research Working Group has also been instrumental in organizing the National Training Workshop, Status and Management of Neotropical Migratory Birds, September 1992 in Estes Park, Colorado. In addition, a working list of neotropical migratory bird species is maintained by the Research Working Group.

INTERNATIONAL CONCERNS

The Partners in Flight is a western hemisphere initiative. It is in the process of actively seeking program participation from governments and private organizations in other countries. In 1992, Partners in Flight financed neotropical migratory bird projects in Latin American and Caribbean countries through: the National Fish and Wildlife Foundation's Challenge Grants Program, the Forest Service's Tropical Forestry Program, the U.S. Agency for International Development, and the U.S. Fish and Wildlife Service's Western Hemisphere Program. Of high priority are projects that: 1) support in-country conservation programs; 2) develop opportunities for training and public education; 3) integrate conservation with sustainable resource development; 4) encourage conservation compatible with human needs, particularly of rural populations in developing countries; 5) transfer knowledge between and within countries; and 6) improve or restore habitats for migratory and resident birds.

CONCLUSION

My hope in coming to this meeting was to stimulate Canadian interest in the Partners in Flight program. Canadian Wildlife Service has participated to some extent already by sending representatives to the first Annual Meeting in Atlanta, Georgia, and by presenting a talk at the 2nd Annual Meeting in Madison, Wisconsin, October 21-23, 1991 (Wendt and Hyslop 1991).

This program is not truly western hemisphere in scope unless natural resource agencies like Canadian Wildlife Service and Forestry Canada join in or implement comparable programs within Canada. Participants at this meeting requiring more information about the program, can have their names and addresses added to the Partners in Flight Newsletter mailing list by writing to Editor, Partners in Flight Newsletter, National Fish and Wildlife Foundation, 1120 Connecticut Ave., NW, Suite 1100, Washington, D.C. 20036. Inquiries about opportunities to coordinate with Partners in Flight can be made by writing to the Chair, Federal Agency Committee, Partners in Flight, Office of Migratory Bird Management, U.S. Fish and Wildlife Service, Washington, D.C. 20240. Future partnerships with Canadian organizations will be most welcomed.

REFERENCES

Finch, D.M. 1991. Population ecology, habitat requirements, and conservation of neotropical migratory birds. U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-205. Fort Collins, CO.

National Fish and Wildlife Foundation. 1992. FY 1993 Fisheries and Wildlife Assessment. National Fish and Wildlife Foundation, Washington, D.C.

Wendt, J.S.; Hyslop, C.F. 1991. International Perspectives - Canada. Pp. 19-21, *in* The Neotropical Migratory Bird Conservation Program, Second Annual Meeting, Madison, Wisconsin. Copies of the proceedings can be obtained from National Fish and Wildlife Foundation, Washington, D.C.

DISCUSSION

Question by Ms. Hannon: We've identified some similar goals to what you have. One of the things that we really need is more detailed information about some of these neotropical migrants on the breeding areas in western Canada. Does your organization have research money that can support some of these studies?

Response by Ms. Finch: The principal funding institution in this program is the National Fish and Wildlife Foundation. The National Fish and Wildlife Foundation will review grant proposals from any organization, whether it's in the United States or Canada or any developing country. If a Canadian is interested in accessing that grant system, they can write to the address that I've listed for the newsletter. It's the same address to get a package request for proposals. The National Fish and Wildlife Foundation has four funding cycles each year. I think they're in the middle of one of their funding cycles.

Question by Mr. DesGranges: I was interested in the map that you showed us of the United States and the places where a large proportion of the neotropical migrants declined. Did the people who produced that look at common natural life history traits of the species that were declining? What are they doing when they're in the north, and when they're spending the winter in the south?

Response by Ms. Finch: What we're doing at this time is trying to address the question of what the population status of that species is, and why is it increasing or declining? The four working groups that are regionally oriented are each coming up with a matrix approach to identifying or prioritizing the most sensitive species. Their life history attributes, and their population trends are the types of criteria that are being used to classify species. It seems fairly obvious that the most common species and the ones that are actually increasing, or that their populations are stable are not the species that we really want to focus our conservation and management attention to. We want to identify those species that are declining. We want to identify why they're declining, and we want to implement procedures for restoring their populations.

Question by Mr. Desgranges: I have a second question. It looks like the birds from eastern North America, are spending the winter in the Caribbean and in South America while birds from western North America, spend the winter in Mexico and Central America. Is there a difference in the proportion of those birds that are declining? Is there a larger proportion of birds in eastern North America, that are declining as opposed to those in western Canada?

Response by Ms. Finch: Yes. The best information we have on declines is for eastern North America. The best information on population trends overall is for eastern North America, where we have a sufficient sample size to determine population trends. Information in the west is really not sufficient at this time to determine. Overall, I think there's an agreement that the problem's more serious in the east, and that it's not clear whether there is a problem at all in the west.

BREEDING BIRD SURVEYS AND THE BREEDING BIRD CENSUS

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Sackville, New Brunswick

ABSTRACT

A brief review of two major bird-counting approaches was provided. The Breeding Bird Survey (BBS) is the most widespread bird monitoring program in North America. The BBS methods for survey and analysis were discussed and problems identified. A capsule summary of Canadian survey results suggested that declines in neotropical migrants were not prominent. Most declining species that breed in Canada winter in the United States.

Use of census plots is the most systematic approach to study of bird densities and communities in specific habitats. Methods were outlined with examples of field maps and species summary maps. Habitat maps allow recognition of habitat use by a species in conjunction with habitat maps. Census plot data from Canadian boreal forests were summarized and synthesized in a 1977 publication. The database has been maintained and expanded, and is now being computerized.

INTRODUCTION

This presentation deals with two of the more important approaches to counting birds that provide data to address the problems that the workshop was convened to consider. Neither method is new, and both have been described many times. The data arising from these surveys have not been used as often or as effectively as they should be, for various reasons.

THE BREEDING BIRD SURVEY

The co-operative Breeding Bird Survey (BBS) is the most widespread monitoring method used for many species of migratory birds in Canada and the United States (Robbins *et al.* 1986). It was started in 1965, by adapting a method used since the 1930s for monitoring numbers of game birds. All birds under study are counted at stops spaced at regular intervals along a predetermined route. Routes are selected within the latitude/longitude grid of degree-blocks using quasi-random sampling. Each route comprises 50 point-counts, of 3 minutes each, at 800-metre intervals, starting one-half hour before sunrise. The entire exercise takes place between June 1 and July 7 each year, and requires 4-5 hours (plus travel time) for each survey.

Most surveys are carried out by interested volunteers. Few professionals have the necessary expertise in bird identification to provide extensive coverage. Governments have been reluctant to hire or deploy additional staff for this purpose. Figure 1 shows the BBS coverage achieved in western Canada during the first ten years of the surveys. Coverage since then has become more extensive, and there are more surveys in eastern Canada and in the U.S.A., resulting in large data-sets which require computer manipulation and complex statistical analysis.

The BBS uses a simple data-collection procedure to avoid confusing or discouraging volunteer observers, and to collect information on as many species as possible. Because many factors that influence the data are not well-standardized, there are difficulties in interpreting the results.

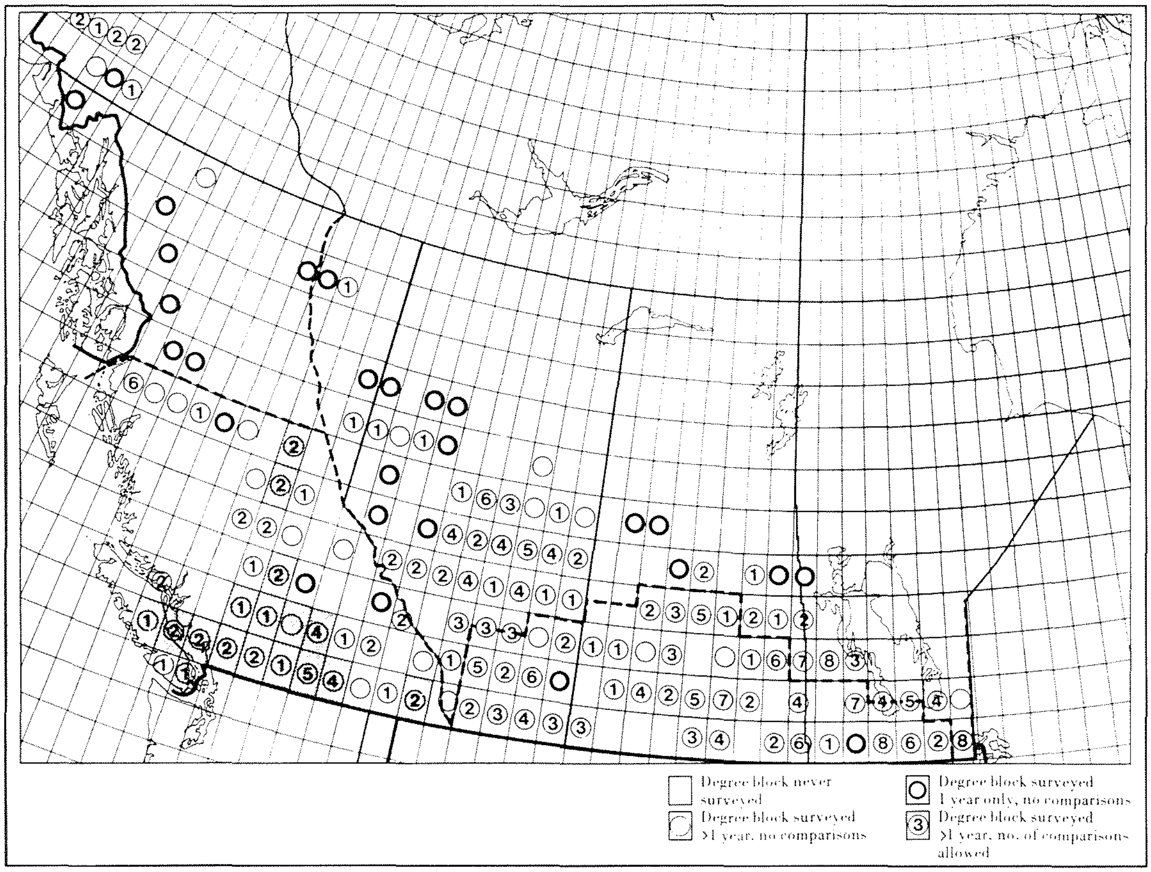

Figure 1. Frequency of comparable coverage, Breeding Bird Survey, western Canada, 1966-75 (from Erskine 1978).

Birds are sampled in all habitats. No attempts to assign individuals to specific habitats are made. The surveys are done along roads, so that birds associated with the roadside edge are better represented than those confined to the forest interior. This bias is amplified because bird songs can be heard at greater distances in the open, including birds along the right-of-way, than through the forest. This poses more of a problem in the boreal regions where forests are the main habitats. Surveys in boreal areas also are limited by availability of all-weather roads.

The BBS coverage becomes less extensive in the north (Figure 1) owing to scarcity of qualified observers. Most human influences affecting birds, other than resource extraction, decline with distance from human population centres. The BBS was intended to monitor the effects on birds of human actions. Farther north, beyond the range of commercial forestry, bird density and diversity decrease roughly in parallel with the trend towards poorer and less productive forests. This was evident on BBS routes along resource roads in the northern wilderness.

There are problems with BBS analyses. The original analysis method "chained-together" surveys with comparable coverage from one year to the next. Only about 60% of the surveys done in each year could be used which was not an efficient use of volunteer effort. The resulting trends (Figure 2) were easy to understand. A more serious problem with this treatment, to statisticians, was random (chance) variation. When recurring random changes in a species were "chained-together" with real changes in the same direction, it might appear to increase or decrease much more dramatically than was really the case[1].

Recently, BBS routes have been analysed using route-regression, a method that allows use of all routes surveyed twice or more by an observer in a comparable manner. About 80% of all surveys are used, and this analysis method avoids the problem of repeated random variations. Producing annual indices is much more complicated using route regression, and the trends obtained usually require periods of 10 or more years. Trends are influenced by the weighting systems used to account for variations in sampling intensity, duration of coverage, and bird density. Canadian and American statisticians independently derived route-regression analysis programs and weighting systems that started from the same principles. The limited comparisons made using the same data-sets gave results that agreed to some extent, but with many differences because the weighting systems differed. The credibility of the BBS could be undermined because of different results that arose simply from the choice of different weighting factors.

At present, the BBS is accepted as a useful monitoring tool. The data-set is not perfect, but it is not unreasonably flawed. The only other data-set of equal or greater extent and duration is the Christmas Bird Count, which is less standardized and thus harder to use effectively. Several independent surveys have validated the BBS results as representing real trends in direction if not always in size. Supplementary methods may be helpful for tracking species poorly sampled by the BBS. The most important requirements for continued monitoring using the

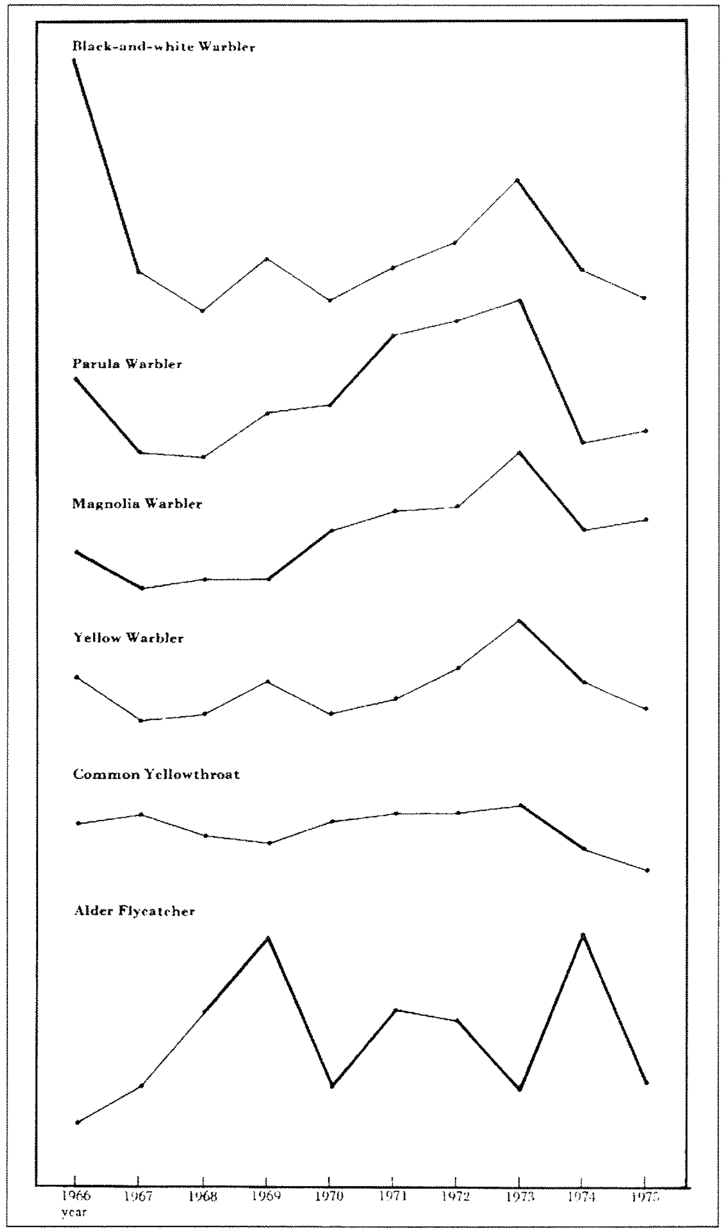

Figure 2. Trends in index numbers for bird populations, maritime provinces (from Erskine 1978). Heavy lines indicate statistically significant changes.

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[1]Even statistically significant changes can arise by chance; if enough surveys are made, chance variation in song frequency may result in one species not being detected during most of the stops that might have sampled it. For example, the significant change in northern flicker in Figure 3 was not borne out by field experience of active observers in the region, and was probably a result of random variation. The usual 95% confidence (P<0.5) attached to statistical significance means that a random change should not arise more than once in 20 analyses. As we now analyze data for over 80 species in each region,and our analysis span more than 20 years, we can expect several such changes to arise each year.

BBS are maintaining the intensity and continuity of coverage. This has been and remains the major problem for the BBS in boreal regions.

Analysis of BBS data collected in Canada indicated most breeding birds that showed sustained declines were not neotropical migrants. Rather, they were common birds of farmland and edge that winter in the United States. American analyses have not addressed that issue.

BREEDING-BIRD CENSUS PLOTS

The second bird-counting approach involves bird census plots, first treated by Williams (1936). These have been termed mapping censuses, spot-mapping, or breeding-bird censuses. This approach is used in Great Britain for monitoring numbers of breeding birds, but elsewhere a consensus has emerged that it is too labour-intensive for economical use on large areas. Nevertheless, the intensive coverage provides a more complete picture of the continued presence and breeding activity of the birds, in areas of known habitat, than is obtained by other methods.

Breeding-bird census maps the locations and activities of all birds detected during repeated surveys of measured plots. Figure 4 shows part of the map for one day's survey of a plot near Dore Lake, Saskatchewan, established in 1973 and re-established in 1990. The plot is a 23 ha grid 600 m long and 450 m wide. Many birds appear in the same places on maps from successive surveys, therefore this is accepted as evidence that the same birds, holding territories, are involved each time.

The data from a series of surveys of the same plot are assembled on summary maps, one for each species. Figure 5 represents all 1973 records for ovenbirds (*Seiurus aurocapillus*) on part of a plot in birch/poplar forest on the side of a drumlin at Dore Lake. All individual birds mapped may be recognized as either occupying territories, or non-territorial (grouse, cowbirds,

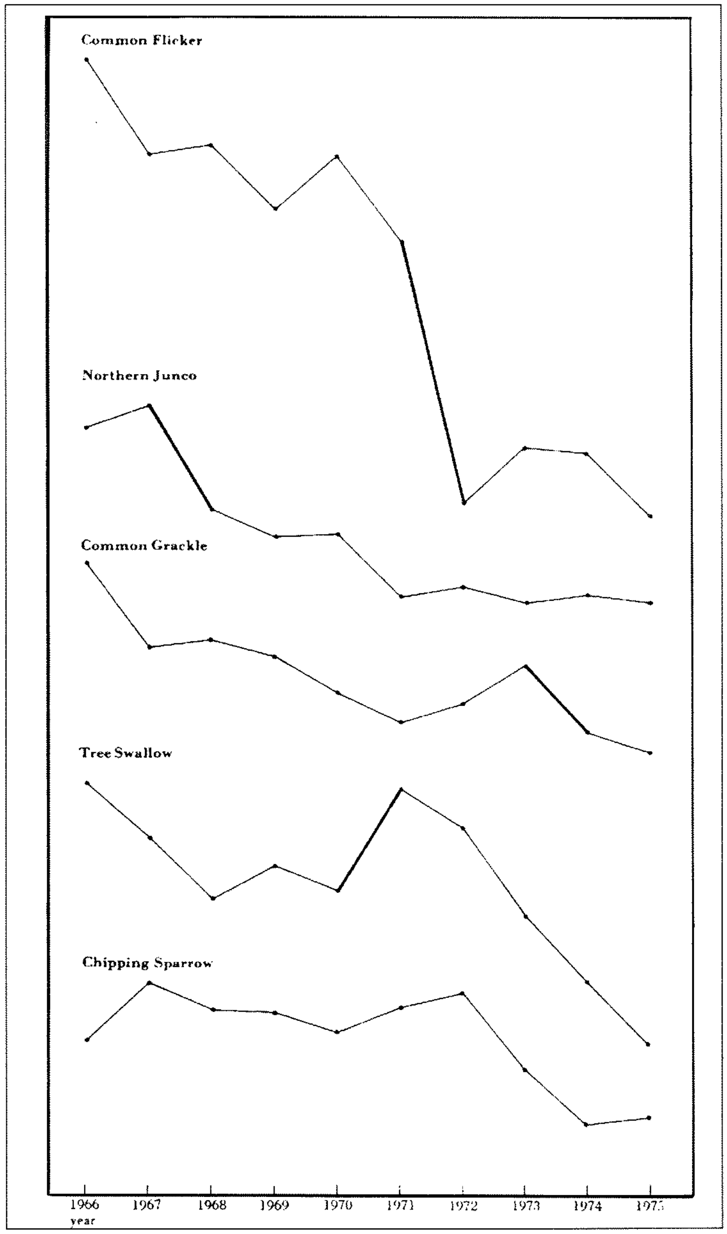

Figure 3. Trends in index numbers, maritime provinces (from Erskine 1978).

finches), or as floaters or visitors, rather than being noted only as present versus absent. This method, thus, gives a more complete picture of the bird community of the habitat than is obtained by other methods.

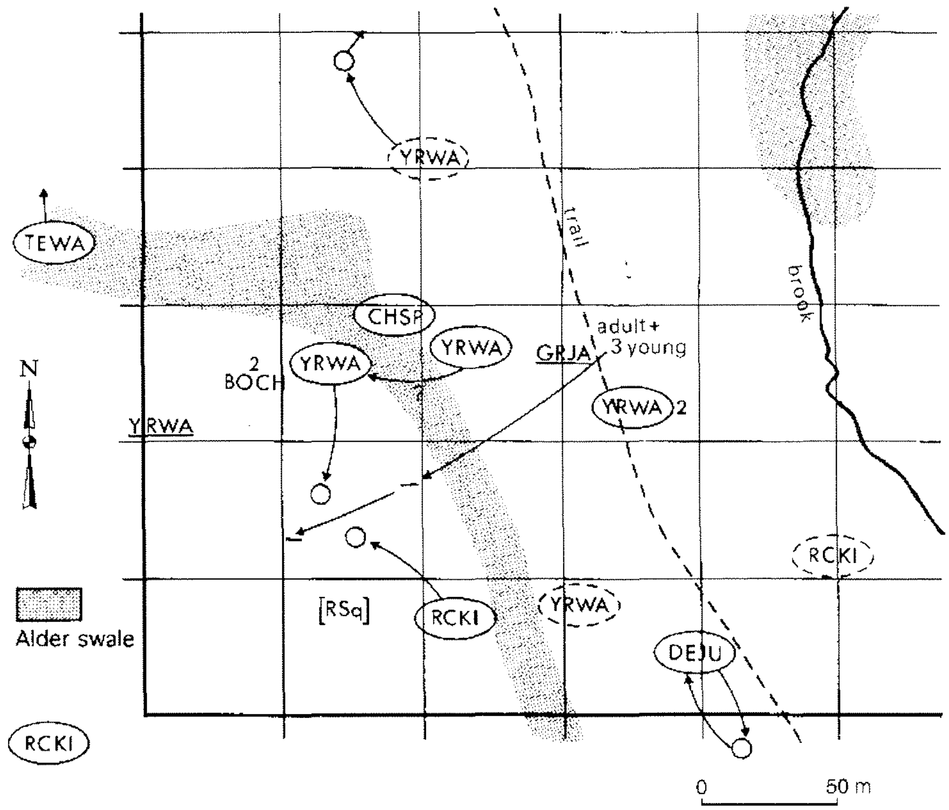

Figure 4. Part of field survey form for one day's census of a plot in black spruce forest near Doré Lake, Saskatchewan. Records outside plot boundary are also mapped.

Symbols shown are standard usage.

Singing bird - species mnemonic circled
Singing at a distance, location imprecise - mnemonic with broken circle
Bird giving recognizable call-notes - mnemonic underlined
Bird seen, silent - mnemonic alone
Birds heard simultaneously - short arrows, one each on two records of same species
Bird moved to new location (marked by circle for singing or line for calling birds, mnemonic not repeated) - long arrows

Mnemonics shown: BOCH - boreal chickadee
CHSP - chipping sparrow
DEJU - dark-eyed junco
GRJA - gray jay
RCKI - ruby-crowned kinglet
TEWA - Tennessee warbler
RSq - red squirrel

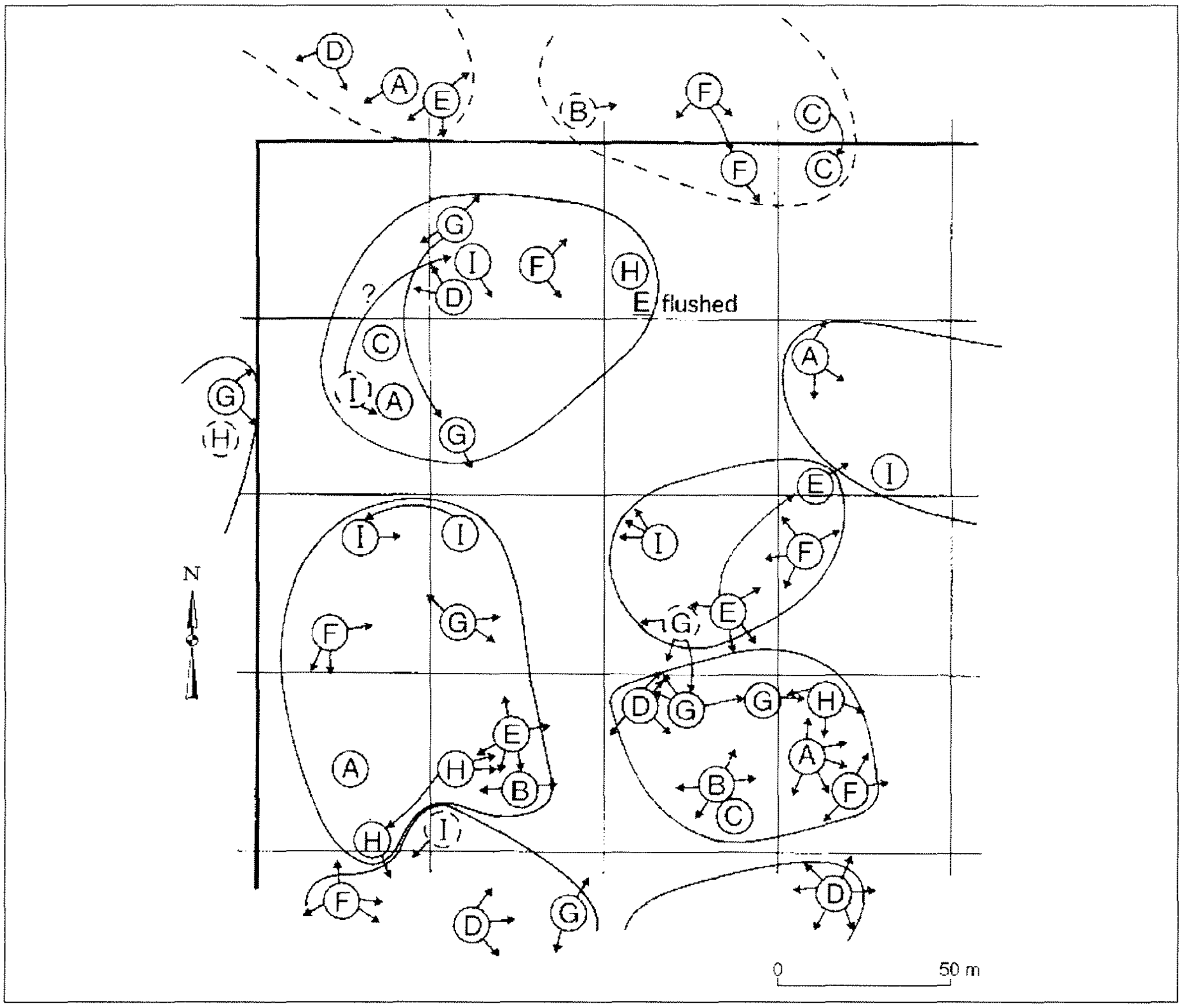

Figure 5. Part of species summary map with outlined territories (clusters of registrations) for ovenbird on 1973 census plot in poplar/birch forest near Doré Lake, Saskatchewan. Note that territories that cross or adjoin the plot boundary are also mapped. Circled clusters represent individual territories, and the breeding density (no. of pairs/sq. km) is obtained by counting the territories, or portions of territories, within the measured area. Each circled letter represents a survey on one date. Other conventions as in Figure 4.

Each plot preferably includes only one habitat type, but this is seldom feasible. Three different habitats, dense spruce, open spruce, and alder swales are included in Figure 4. Superimposing a habitat map on the map for a species allows assignment of individual records to specific habitats. For example, both least flycatchers and boreal chickadees were found on the birch/poplar plot at Doré Lake. The chickadees occurred only in an area with a diffuse understory of spruce beneath the high canopy of broad-leafed trees, whereas the flycatchers were in the canopy, explicitly avoiding the areas with conifers. The Tennessee warbler is commonly considered a bird of spruce stands, and its densities fluctuate in response to spruce budworm outbreaks. In the spruce plot at Doré Lake, Tennessee warblers sang mostly in the alder swales, with a few in clumps of aspen in openings in the spruce canopy. These habitat-specific relationships would not appear as clearly from other survey methods involving only one or two visits to each sampling point.

The information from bird census plots across northern Canada was summarized, with its sources, in the Canadian Wildlife Service report *Birds in boreal Canada* (Erskine 1977). Data assembly has been continued since. A catalogue of census plot sources was released as data accumulated (parts 1-5 in 1971-1984), but few people have been willing to extract census plot data from the original sources. To make this valuable information more widely available, a computerized database of census plot data is being established at the Canadian Wildlife Service in Hull. This is several years from completion.

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DISCUSSION

Question by Mr. Bonar: Tony, you mentioned that there needs to be methods developed for other species. Have you got any suggestions about methods of monitoring populations for owls or woodpeckers?

Response by Mr. Erskine: A survey similar to the BBS, for owls, run at night and in the spring rather than in the summer, was implemented on a pilot stage in eastern Manitoba last year. It is going to continue this year, using volunteers who start after dark and continue all through the night until they give up in exhaustion. I think that is the most likely approach if they can get enough people to do it, and if the roads stand up. We can not do that kind of thing everywhere, because owl-hooting is most frequent in mud season when many back roads are impassable.

Question by Mr. Bonar: Who is the contact for that?

Response by Mr. Erskine: The man who organized it was Jim Duncan who has just taken a position in data base management with Saskatchewan Natural Resources in Regina.

THE FOREST BIRD MONITORING PROGRAM

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ABSTRACT

The paper describes the Forest Bird Monitoring Program conducted in Ontario since 1987. The program was meant to augment the Breeding Bird Survey. Habitat-specific bird population trend data provides effective input into land management decisions. The program was designed to describe changes in numbers of all forest songbirds over time to develop a habitat-specific baseline inventory of forest birds, and to develop regionally accurate habitat association profiles for all common forest birds.

The program relies heavily on volunteers to conduct surveys twice annually during the breeding season. The criteria used to establish bird listening stations and the procedures used to sample birds are described. A number of considerations in dealing with volunteers are discussed including the need for regular feedback on program progress and results. About 3 000 stations have been sampled over the last four years. Statistically significant trends occur with as few as 20 stations over a five year period in cases of dramatic change.

INTRODUCTION

In 1987, the Ontario region of the Canadian Wildlife Service initiated a program to inventory and monitor trends in forest birds. The Forest Bird Monitoring Program was designed specifically to describe changes in numbers over time for all forest songbirds, to develop a forest habitat-specific baseline inventory of forest birds (species composition and relative abundance), and to develop regionally accurate habitat association profiles for all common forest birds. It was intended to build upon and augment the broad regional base of the Breeding Bird Survey (BBS). The program relies on volunteers for annual surveys to monitor trends, supplemented by salaried observers to establish sites and to conduct baseline inventories. This paper provides an overview of the procedures and methodology, and some general comments on habitat-specific surveys and volunteers.

SITE SELECTION AND STATION LAYOUT

Forest stands representative of the major forest habitat types of Ontario are selected as study sites. The site selection is usually made jointly by volunteers, Canadian Wildlife Service (CWS) personnel and personnel from other agencies and incorporates considerations of permanence and access as well as representivity. As well, the CWS has established over 100 sites in protected areas during other forest bird inventories that we encourage volunteers to 'adopt'.

In each forest site, five sampling stations are located 100 m from the edge and 250 m apart. While actual stand size is not specified, it takes an area of at least 25 ha to locate five stations using these guidelines. All stations are clearly marked to facilitate relocation and have flagged trails linking them.

BIRD SURVEY PROCEDURES

The survey procedure used is an unlimited distance point count based in general on the approach described by Blondel *et al.* (1970) that is used by numerous other investigators (e.g. Fuller and Moreton 1987; Robbins *et al.* 1989). Our basic procedure is to wait at least one minute before starting the survey to give the birds a chance to settle down and to provide an opportunity for the surveyor to get his ears 'tuned in'. All birds seen and heard during a ten-minute sampling period are recorded, ensuring that each individual is counted only once. Counting is done by mapping all records on a map sheet, keeping track of movements as best you can, and paying particular attention to simultaneous records. Mapping the exact location and noting movements is the best way to minimize duplicate records. Standard abbreviations and symbols are used to record the status of each bird record (e.g., singing male, pair, female, nest, calling bird, et cetera). The abbreviations are similar to the ones that Tony Erskine showed us for the BBS program. It is critical to record status symbols accurately as they assign breeding evidence. The level of breeding evidence determines whether a bird is assumed to indicate a pair or a single; a singing male, observed pair, occupied nest and family group are considered a pair and all other individuals are counted as singles. A special effort must be made to record all species by guarding against missing an individual even though it is singing clearly. It occurs most often when an observer concentrates on identifying another less vocal bird. Constantly singing birds like the red-eyed vireo seem to be the easiest to 'tune out'.

All participants have a high skill level in bird identification, and observers are encouraged to try to eliminate species identification errors by tracking down problem birds.

Counts are done early in the morning, starting approximately at dawn and continuing for about three hours. Winds should be calm to light (<15 kph). Clear or very slightly damp conditions are best. Counts should not be conducted in the rain. All stations for each site should be completed in one day to make stations as comparable as possible. Observers are allowed to have as many helpers as they require for navigation and data recording purposes, but there must be only one listener per station.

Each site is sampled twice during the breeding season, once during the end of May to early June period and once during the latter part of June. Observers transcribe the mapping data onto a coding sheet, preferably on the same day. This gives us a computer-recordable data base that they send in along with their maps. We cross-check the maps against the data coding and then analyze the data.

DATA ANALYSIS

The highest value for each species during the breeding season is used as the station estimate. Station values are summed to obtain site values for the five sites, which is the only way to relate the surveys to forest stand variables and other available information.

The number of stations required to establish significant trends is difficult to specify precisely because of the variation patterns of the species that are dealt with, and the length of time spent at each station. Using BBS route regression methodology (Geissler and Noon 1981; Collins and Wendt, 1990), statistically significant trends occur with as few as 20 stations over the 1987-1991 period in cases of dramatic change and frequently with 40 or more stations.

HABITAT-SPECIFIC SURVEYS

The decision of whether to stratify surveys by habitat must be based on the nature of the data required, but our experiences may give you some ideas. Habitat-based approaches are most valuable at a local and regional level, and they obviously become more difficult to design effectively as scale increases. Habitat information can be ignored in analysis if it is not needed, but it is often difficult and expensive to collect *a posteriori*. Habitat-specific data can produce specific as well as aggregated regional, provincial and national roll-ups.

Habitat-based sampling protocol should be viewed from a statistical perspective as stratification to deal with heterogenous distribution. Bird species turnover across forest stand gradients is high, so there are considerable statistical benefits in examining trends within similar forest habitats.

Bird trend data provides effective input into forest land management decisions if it is habitat-specific. Because the landscape mosaic is the template in which most bird habitat associations evolved, it is a logical basis for sampling protocols. Natural and man-made landscape changes are habitat-specific so information expressed in landscape unit terms is most valuable.

Volunteers and other agencies are more willing to cooperate and provide financial support to data that is collected on a locally interpretable basis as well as integratable on a larger scale. Habitat-specific data can also meet requirements for inventory and habitat association information as well as providing monitoring information.

VOLUNTEER OBSERVER CONSIDERATIONS

The use of volunteers dramatically expands the scope of monitoring programs and provides for long-term continuity. It is extremely important that programs have clear overall conservation goals as volunteers want to contribute to things that they perceive as being worthwhile conservation efforts. It must also have rigorous methodology that recognizes habitat differences. Many naturalists are suspicious of average values derived from different habitats.

The important point, particularly in relation to the length of time spent counting, is that a survey needs to have an impression of completeness as observers often have a strong interest in the site that they survey. They want it done properly. It may be one of their favourite pieces of woodland. They distrust samples where they feel rushed, and they like to know that they have successfully mapped or counted all of the birds in an area. In general they are much happier with ten-minute counts than they are with three-minute counts. Volunteers provide long-term continuity, therefore it is important that the methodology be satisfying and hopefully fun to them because it is their free time.

Communication is extremely important for long-term support. Regular feedback and newsletters seem to work well, and periodically, although not often enough, we provide our observers with regular feedback on program progress and results.

HISTORY OF PROJECT

About 40 volunteers surveyed 310 stations (62 sites) in a 1987 pilot project to examine the feasibility of a volunteer-based forest bird trend monitoring program. The methodology was similar to the one described herein except that observers also used an imbedded 50 m radius fixed distance plot in the centre of the unlimited distance plot. Difficulties in estimating distances led to abandoning the 50 m inner plot. The pilot project was successful and the program has operated on a modest scale of about 200 to 300 stations every year, expanding somewhat in 1991. The five year database is presently being analyzed for trends and to better understand the characteristics of the data set.

Related projects using the same methodology have concentrated on inventory and habitat associations of bird communities in the boreal forest in relation to forest ecosystems. About 3 000 stations have been sampled over the last four years. A model to predict bird species composition and abundance in relation to forest type has been developed for northwestern Ontario. A more complete description and an evaluation of the methodology are in preparation.

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DISCUSSION

Question by Mr. Savard: What type of variation do you have for people using density as an indication of habitat preferences and often using only one year of data? Do you have some idea of how wrong they could be, or are most of your species fluctuating from one year to the next?

Response by Mr. Welsh: It is impossible to answer that question in a simple way because some species are extremely stable and show very little variation on a station or a site basis, and other species seem to be wildly erratic. It is exceedingly difficult to generalize. There are no particularly obvious life history attributes, migratory habitat attributes or other things which would allow me to say that there are different groups of patterns of variance.

What I would say is that species with a high degree of variance seem to show similar patterns in variance across various regions of the province so that species that are wildly variable in southern Ontario seem to be equally variable in the northeast or the northwest.

In comparing site and station data, the station data generally tends to be much less variable, and that is largely due to the fact that the habitat specific association is much more precise at an individual listening count basis. The larger your collection of samples and the less attention you pay to habitat heterogeneity, the more variability you have to cope with. It is difficult to answer that question beyond that.

SESSION REPORTS

and

WORKSHOP CLOSURE

SESSION REPORTS

SESSION 1 - Overviews

Tony Diamond: I've asked the chairpeople of each session to briefly summarize the discussion that took place during their session, and any conclusions that came out of it. I also asked them to get their speakers to provide their ideas on the top five research priorities in this area. Most of them have submitted their ideas, and in our brainstorming session last night, we attempted to summarize them into a smaller number. For those people who weren't here for the brain stroming session, I'll try to summarize them as clearly as I can after the chairpersons present their summaries.

The first session was essentially overviews of the problems of biodiversity. Speakers in this session discussed how to measure biodiversity in forest ecosystems, and what we know in a general way about ecological relationships of boreal forest birds in this part of the world. I think one thing that came out of that was that no single biodiversity index (at least none that's been invented so far) is going to do it. I think one of the great difficulties in using indices is that they tempt you to park your brain and rely on the number.

Malcolm Hunter made it very clear that you shouldn't park your brain when trying to measure the diversity of anything. You should use the index as a tool but not rely on it totally as your value system. You need understanding of the system as well, and you need to be able to measure things like distinctiveness and significance in a way that current diversity indices don't adequately do.

Alan Smith and Ed Telfer presented independent overviews of the boreal forest avifauna. Two things jumped out at me about that. One is that the correlation of different attributes of the species in relation to the habitat does give us a powerful tool for grouping species together when we're looking at trends. When we're looking at habitat relationships, it enables us to reduce the sample size of 146 or 148 species, (whatever it is), to a more manageable total. I thought it was fascinating that the proportion of species does seem to vary in relation to the proportions of different habitat types in relation to fire as the major natural disturbance. That gives us some kind of a template against which to match changes in abundance of different species.

SESSION 2 - State of knowledge of impacts of forest management on birds in boreal forest

Jean-Pierre Savard: I'll try to be brief. In two words, there's few hard data and a lot of speculation. I'll list of a few concepts that were addressed by the various speakers.

One was a concept of critical period. We saw with the blue grouse study that clear-cutting can be good for some birds. Also, it raised the prospect that they're not so good in winter. When we look at a given forest or land area, we should consider all seasons. There may be a critical time of a species for which a certain habitat is crucial.

The second talk addressed the top predators (the owls) and gave an example of a species in British Columbia and on the west coast that you could call old-growth dependent species. We don't seem to have that clear distinction in the boreal forest, but what we may have in the boreal forest ecosystem is that some species that may be habitat specific, or they may have critical habitat needs at the given time. The management problem would be fairly similar to the one of the spotted owl. There is also the challenge of how we manage for those birds that are on top of the food chain and need large areas, especially when they have specific habitat requirements.

We had talks by Rick Bonar and Dan Welsh that addressed topics that appear different, but are very similar. How do we translate wildlife information into information that a forester or a person in the field can use? Dan looked at the provincial forest classification system, and superimposing it on bird distribution. There was a need identified that the temporal component should be added to that. Rick looked at decision support systems, habitat suitability models, and habitat suitability indexes. They both do the same thing, more or less. The habitat suitability model takes data usually collected by the forester, then trying to create a profile for a given species of bird and trying to map that bird onto the habitat map. We have to be careful with this approach, the attempt to classify something into a set of pre-identified criteria. Most of these models have not been tested. The few that have been tested have proved unreliable. It's a good approach as long as we recognize its weakness and the danger associated with it. Imagine, if the data is not good, you could prescribe a management system for a given group of animals that is completely wrong. The worst thing is that you will have a sense of security because it's based on a model. There was a need identified at least to test some of those models, possibly refine them, but I would say be cautious with them.

Another study by Dan Farr looked at the distribution of wildlife across various age classes, especially birds. This is very important information that we need for most of the forest types in the boreal forest. The use of that data is that you can find out in what part of the successional pattern a given species can function. The nice thing is that you could couple it with a GIS system and extrapolate in the future what your landscape is going to look like. From a very broad perspective ,say that the species is going to decrease, or if it's going to increase, you may identify some habitats or some successional stages that are critical.

Jean-Luc DesGranges talked about natural versus man-made change, and pointed out that there was some differences. Some speakers in other sessions also mentioned that forest exploitation is not exactly the same as what occurs naturally with insects and fire. We even had some discussion after the talks about whether or not we should model our forest exploitation strategy on natural phenomenons. The idea is interesting, but dangerous. We are facing a set of species that have adapted at different times in the boreal forest, and natural phenomenon that do not occur singularly. Insects are usually associated with forest fire, and sometimes they occur simultaneously or very close together. If we take something like patch size and try to bring it into the man-made system, we may make some big mistakes. Maybe patch size is good when you get an insect infestation, but it is not good any other time. There are all kinds of different interrelationship that could apply. The natural pattern should be explored in terms of trying to define relationships or to give us some idea of what the processes may be. Also, there was some discussion that if we use a natural pattern, then we'd be safe. That would cover all the species. There's a lot of assumption that goes with that that are not necessarily met. Not all species may be adapted to that fire regime. Some species that we may have some concern for may be adversely affected. They can't subsist in the boreal forest and they're not doing very well in a natural situation. There is a problem of defining what a natural situation is. Is it 20, 100, or 500 years ago? Is it what is happening in Manitoba, Quebec, and Ontario? Frequency of fire is different. One of the things that was brought up was a lot of the models are based on density. Looking at density relationship between habitat type and the number of birds shows that there is a real need to assure ourselves that density is related to reproductive success. There are a few studies that show that sometimes it's not. There's also the danger that several studies are based on one year of data, and at least for a few species the change in density could be quite drastic. Some of the relationships may show the species in low abundance that year, but that it didn't occur in a given habitat. We have to ensure that future research incorporate at lease two years if possible.

Finally, the last speaker in our session described a new experimental approach to forest exploitation. This is probably what we have to do now, take advantage of a system we modified, and learn from it. In a way we're in a unique situation. The ecologists have always wanted to do that; modify the system and see what happens. They've rarely been able to do it, but with forestry practices, this is the ideal experimental situation. We haven't thought in those terms before, because we haven't had the resources or the time, and there hasn't been much interest in forest wildlife biology. The time is here now. We've all seen how urgently data is needed, because decisions have to be made now. I've pointed out the risk of making a decision based on very little data.

SESSION 3 - Landscape Issues - "Scaling up" from the stand to the ecosystem

Rick Bonar: The first speaker was Mac Hunter. He talked about managing biodiversity in large spatial and temporal scales. The first thing I got from Mac's talk was the interesting analogies he used to remind us that scale is relative. I guess you could say that human hair looks like a forest to a flea, but if you extend that, you could say that humans look like a flea to a forest. Now, within a stand, a habitat type, or an ecosystem association, we should probably manage a variety of scales that reflect a variety of organism sizes and natural patterns resulting from natural disturbance regimes of a single tree event up to a catastrophe such as a forest fire. Mac talked about natural patterns that tend to show a negative exponential distribution. He used examples, such as the sizes of forest fires and soil units. I think that links to his hypothesis that if we're going to translate these principles to management strategies, there really aren't any rules. We should not get hung up on polarized adjectives, because really there are few gray adjectives. Most are black and white, and we need to look a little bit more in the gray area. How we might do that relates back to an approach he called the triad approach, which seems reasonable. It would have a mix of three basic forest components. Those would include reserves, multiple-use areas and intensively-managed areas. He felt that we should apply the appropriate criteria to individual ecosystems of the circumstances. Although he didn't discuss them, he said that there are other pieces of the puzzles such as economics and social considerations that are also very important to consider.

The second talk was by Dave Euler: how to achieve the impossible; managing for landscapes and biodiversity. Dave's talk focused on the qualifications required and pleasures derived from a career of decision-making in the Ontario Ministry of Natural Resources. He talked about a policy hierarchy for management. The ranges were from strategic goals and objectives, down through policy strategies, specific objectives, and back down to the lowest part, which he called guidelines and rules. He lamented that most organizations don't seem to be able to get to those strategies and specific objectives. Criticisms come in at the level of rules and guidelines, and the system breaks down very rapidly into arguments over those specifics and alternatives. It would have been tempting to throw up your hands and say it can't be done, but Dave didn't do that. He instead outlined additional problems. How can an organization of 5 000 people overcome inertia and change for the better? How can government measure and prove good management to the public? How can managers and their constituents talk a common language? Dave went on to outline examples that might serve as a basis for discussion to try and solve some of these problems. I submit that even if the situation seems hopeless, we're ahead when we have individuals like Dave, who are trying to develop solutions. There are no hopeless situations. There are only people without hope.

Susan Hannon presented the third talk about first-year results from a study of nest predation and forest bird communities in fragmented aspen forests in Alberta. Repeating Susan's caveat, we should not make sweeping generalizations of one year's data. Her message was that understanding of boreal forest systems cannot be extrapolated from knowledge gained elsewhere. In other words, we should not practice paradigm prostitution where we develop one somewhere and prostitute it somewhere else, in hopes that it will also apply. Susan concentrated on neotropical migrants for her presentation, and she found that there were some area sets of species. There was a direct relationship between number of species and area of the fragment. Predation rates were low compared to other studies, and yet they were higher in the boreal artificial nest than they were on the ground. She wrapped up by making some interpretations regarding the applicability of her research to an important area, (i.e. fragmentation in forest systems, as opposed to agriculture-forest interfaces). She outlined (nicely I thought) some of the research needs for forest birds in that area. It looks like we need to do a lot of work with respect to the boreal forest.

Finally, Jean-Luc DesGranges talked about landscape approaches to sustainable forestry. He talked about spatial heterogeneity as the underlying concept of biodiversity. Management strategies should be designed to mimic natural processes. These appear to be the best choices for landscape management. Landscapes should probably contain a mosaic of disturbances (in other words the same thing that Mac Hunter said). We need to mimic the scale, size and distribution of disturbances with our management schemes. This multilayered approach could reduce vulnerability in forest systems, and risks such as insect attacks, fires and bird habitat loss. He summed up with a discussion of land use options that include more reserves and areas for intensive and extensive management. This is another way of saying the triad approach advocated by Mac. The reserves are the same. The intensive management is plantation type forestry. The extensive management is multiple-use areas. The challenge will be, as Dave said, how do you put that together into a comprehensive program?

To conclude, I will borrow an analogy from a comic, whose name I don't remember. Her routine was about the perils of one-size-fits-all panty hose. Some of her comments and contortions were very graphic and very funny, but her message was women come in different sizes, so should panty hose. With respect to managing forest landscapes, the message from the speakers was clear. We should not listen to salesmen trying to sell one-fits-all panty hose.

SESSION 4 - Foresters' prespectives on integrated resource management: where are we headed?

Diana Boylen: We had two foresters who have worked with a number of biologists and two biologists who have worked with a number of foresters. We were off to a good start.

Ian Thompson was the first speaker. He reiterated some of the experiences that others have mentioned as well; the need for foresters, biologists, and indeed the general public to use the same concepts and definitions when we talk about multiple use, integrated resource management, sustainable development, and biodiversity. There is also the need to dispel and re-examine some old truths, such things as clear-cutting simulating fire. He reviewed a number of the requirements for forest planning. He also reviewed a number of the requirements for integrated resource management planning. He highlighted six management strategies for wildlife management within a forested ecosystem, and established what he thinks is a major research priority (biodiversity associated with postlogging). This has to be looked at in terms of the processes, structure and function as well as through dimensions of space and time. He also looked at the problem of landscape scale and identified five specific research needs.

With that sort of general overview, we went on to Jack Spencer, who as well as Daryll Hebert comes from a forest industry background. He reviewed the past history of PAPCO and Saskatchewan Forest Products in forest management planning and operations in central

Saskatchewan. He gave some illustrations on the impact of Weyerhaeuser coming to Saskatchewan. He gave a history of the Saskatchewan Forest Habitat Project. He talked about the development of a number of cooperating members, and of the types of decision-making processes they've had to go through. Their main objective is a fully integrated forest management strategy for their FMLA within about five years. The wildlife and timber management has been done jointly in the same time and space. He talked a bit about the pilot project within the FMLA and the development of habitat evaluation procedures, habitat suitability indices and their GIS.

Lorne Brace reviewed some of the attributes of a 1955 and a 1992 forester. It was interesting to see that there are still a number of 1955 foresters. I'm sure if someone had done it for biologists, we'd find a number of 1955 biologists around too. He focused on a number of issues that the 1992 forester is looking at; 1) the need for landscape rather than stand management, which is probably what he was taught in school; 2) the need to look at new decision systems whether they're decision support systems, computerized ones or others; and 3) new operating ground rules, particularly for mixed wood systems; better tools; whether they're preharvest silviculture prescriptions or mappable ecosite classifications. Lorne also dwelt on the long history of forest research in this region and acknowledged the problems of changes in resourcing of research and of the nonintegrative approach that has occurred over time. Perhaps because we are in different branches and different divisions, there are difficulties in interpreting the research that is there to an operational size and scale. He also picked up on what Ian had to say on the definition of terms such as biodiversity. I think it's something that we need to spend quite a bit of time on as well as new forestry concepts, whether we're talking the new forestry, the redesigned forest or the home place. These are a lot of new concepts that have been broached for forest management. As several people have said throughout the meetings, they are much easier to talk about at the policy and program frameworking level, than they are at the operational level. Lorne also highlighted social forestry issues as greatly neglected, not only in the world but also in Canada. Biological sciences generally have not interacted very much with the social sciences, and it's been to our detriment. He concluded by expressing some concerns with the objectives and expectations of the Green Plan and the model forests. I think that cautionary note is something that we should all take back to the places where we work, because the general public certainly has greater expectations than we have.

Daryll Hebert reviewed the development of the Alberta-Pacific forest management agreement lease area in Alberta. This is probably one of the largest land areas being looked at in North America for forest industry development. He too reviewed the basics of an IRM planning process, but just for wildlife and timber as examples rather than the whole list of possible categories. He outlined their forest planning structure at Al-Pac, and he made a number of observations on the need for attitude shifts among traditional forest planners and managers. He reviewed his experience with integrating ungulate research into the planning process of companies and of government and the need for researchers to get involved with planning (the no-arm's-length and the take your data to the table solutions). He also seems to think that policy and general goals are easier than management objectives and activities on the ground (I'm not sure whether I really agree with this as someone who does a lot of policy and planning work). Nevertheless, that's where a lot of the companies are at. That's where the rubber hits the road. They're having a lot of problems doing that. His parting comment was that biologists and foresters need to be more like the lion and the lamb, and a lot less like a pair of butting rams in the wilderness.

SESSION 5 - Databases and Information Networks: What do we have, and what do we need?

Wayne Pepper: Well, we heard basically what we had, and we really didn't hear very much about what we need. However, I might be able to draw a few conclusions from what I heard from people who said what we have. We heard people from forestry, people from wildlife, and we heard people who are working in the integration area like Bob Stewart. We heard from Bruce Lyle talking from a private individual viewpoint who would like to see things on a more integrated approach or basis.

I think one of the conclusions I drew was that our inventories or our understanding of the forest is improving, slowly maybe, but it is improving. We're seeing improvements in the technology and the methodology of collecting information, both from the forestry and the wildlife side. We're also seeing some major improvements in handling the data, and coming to understand the data through a variety of different analyses. One thing that does come out is that we're on the threshold of realizing how important the other side's data is for our particular program, whether you're talking from the wildlife side or the forestry side. The wildlife people (we're seeing this here in Saskatchewan at this very moment) are really dependent on the forest inventory. The forest people are really dependent on the wildlife people giving them some information about these other things in the forest. That was really obvious from the shakedown of the presentations this morning. I think Bruce Lyle said it best. Being able to take all this information and integrate it in a useable fashion so that we can plan and develop research proposals that are meaningful and integrative will promote adaptive management like Bob Stewart described.

We've come together here. Last night we tried to come up with a research picture for us to look at. We got unfocused. What we really need, (as a result of our efforts here the last three days) is to become more focused. I think what we've done has been a good start. We need to go back to our own areas of work and continue thinking that way. That's basically what I got out of this morning's program.

WORKSHOP CLOSURE

Tony Diamond: Before I wrap up the workshop, I want to give a couple of personal impressions from last night's meeting. It was confusing, and there were a lot of conflicting views brought out there that hadn't come out in the main discussions and main sessions. That was good, I think. What it tells me is that next time we've got to have more of that sort of session. The two conflicts that I identified are focused on what is the most important question to answer first.

We know there's an awful lot we need to know about boreal forest bird ecology. The difficulty is where to start and what to do first; not necessarily what is most important, but what is most urgent. I think the two differences were whether the most urgent question is to assess the difference between successions that happen following natural disturbance versus post logging disturbance. Is that the most important thing we should look at first, or is the issue of the size of patch, particularly in relation to the diminishing size of clear-cuts going on in current forest management, the most urgent issue? I don't think there was a consensus on that. I feel these were two perfectly legitimate points of view, and that is not a problem on a national scale. Each agency designing its own research programs can go away and make its own decision. Within this specific region, that is a bit of a problem. We have to make a decision on that pretty soon as to which way we go, but I think there was a lot of useful feedback in that session.

Another conclusion that did come out with consensus (Jean-Pierre referred to it earlier) was that continuing to measure bird density in relation to habitat is not enough. We have to measure bird use and productivity in those sites as well. That's going to be expensive, but it is going to be important. As a comment on bird habitat research in general in this part of the world, (not just forest birds) the inertia that comes from doing what you've always done because you know how to do it, and it's what everybody else has done, is a very real pressure. We must ensure that our research steps beyond what we already know and the techniques we already have, and asks new questions as well. Simply measuring the old things because it's what we know best how to do is not good enough.

Another thing that came out was the need to focus our research on the landscape level of the effects, not at the stand level. That's been brought up in a number of talks. We can do that because forest management tends to be at a landscape scale. In most other habitat bird issues you can't do that because land ownership isn't on a big enough scale. I don't think we got to grips with Dave Euler's particular preoccupation of setting policies, goals and objectives. I think there was general agreement that it is important to do that, but the general feeling was that the data on which to do it are not there. That will frustrate Dave enormously, because he's heard it so often from so many other people, but I think his perspective was a very useful one. It wasn't one that biologists generally thought about a great deal. It's clear that we have to, because we're operating as biologists in a policy framework we're not used to. Foresters are operating in a public policy concentration framework that is relatively new to all of us.

It's very difficult to assess the results of the workshop when you've been personally involved in setting it up. You're not objective. I can only say that I got a great deal out of this meeting. It's the first of its kind (to the best of my knowledge) in the country. I think, therefore, it's not going to meet expectations, whatever they might be. There were a lot of new ideas, people talking to each other who need to talk to each other and need to not just go away and talk to themselves again. I do want to thank a few people. The person I want to thank most of all is the person without whom this wouldn't have happened; Harvey Anderson, who did all the work. I must thank the speakers, because without them it would have been awful quiet. They were the people who generated the ideas

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