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Northern Spotted Owl Workshop Proceedings

January 21–22, 2004

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Kathryn Zimmerman, Kym Welstead, Elizabeth Williams, and Jennifer Turner (editors)

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Forestry Innovation Investment Ltd.

ABSTRACT

The Northern Spotted Owl (*Strix occidentalis caurina*) is listed as endangered by the Committee on the Status of Endangered Wildlife in Canada, and the current Canadian population is estimated to be less than 33 pairs. As part of the process for recovery planning, the Canadian Spotted Owl Recovery Team, supported by Interfor, is working with consultants to develop a spatially explicit habitat supply model that is responsive to various management and population parameters.

The Northern Spotted Owl Workshop, held in Richmond, British Columbia, January 21–22, 2004, was hosted by the B.C. Ministry of Sustainable Resource Management, the FORREX–Forest Research and Extension Partnership, and the Canadian Spotted Owl Recovery Team. A key goal of this workshop was to provide a forum for scientists, stakeholders, and decision makers to collaborate in the development of scenarios for the model, the outputs of which will provide management options for the consideration of decision makers.

The goals and objectives of the workshop included promoting an understanding of federal and provincial responsibilities for species recovery, introducing the best available science around the Spotted Owl, and discussing the need for socio-economic considerations to be integrated into recovery planning. The workshop covered a broad scope of issues related to Spotted Owl demographics and habitat management, and also examined the application of models to explore these issues. In addition, the workshop brought together a broad spectrum of interests in Spotted Owl and established connections between key players.

An important outcome of the workshop was for participants to understand the process of building the model–what information will be required, what are the limits to some of this information, what questions will the model be able to address, and what is the scope of habitat and population parameters that can be considered through the modelling process. Stakeholders were apprised of the status of the modelling and recovery planning processes, became more aware of the responsibilities and steps in these processes, and how these steps, which include socio-economic analysis, will ultimately inform decision makers. The workshop also provided an opportunity for stakeholders' concerns and questions, and provided a forum for collaborative input into the modelling process. We hope that there will be increased involvement by key knowledge holders as the recovery planning process moves forward, and that participants continue to work together to find solutions to Spotted Owl recovery that meet everyone's needs.

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B.C. Ministry of Sustainable Resource Management

FORREX–Forest Research and Extension Partnership

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A great many people contributed towards making this workshop a success, and we express our gratitude to several key players. John Innes, Director of the Centre for Applied Conservation Research at UBC, did an excellent job of moderating and facilitating the workshop. Warren Mitchell, Director of the B.C. Ministry of Sustainable Resource Management, provided the welcome and closing address. Huge thanks go to the modelling team: Glenn Sutherland and Dan O'Brien of Cortex Consultants, Inc., and Andrew Fall of Gowlland Technologies, Ltd., for providing input into workshop goals and objectives, for providing a set of guideline questions to be discussed for the break-out sessions, and for facilitating the afternoon full forum scenario development discussion. We thank all the presenters for their contributions, especially those who came from the United States to provide insight into how Spotted Owls are being managed south of the border. Thank you to our sponsors, the B.C. Ministry of Sustainable Resource Management, and the province of British Columbia through the Forestry Innovation Investment Ltd. Thanks also to all the workshop attendees who participated in the break-out sessions. Peter Nemeth and Andrew Karpiak from Delta Hotel provided conference services.

Conference welcome

Photo by Rex Turgano

Northern Spotted Owl

Photo by Jared Hobbs

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INTRODUCTION

The Northern Spotted Owl (*Strix occidentalis caurina*) is listed as endangered by the Committee on the Status of Endangered Wildlife in Canada. In 2001 it was declared Canada's highest priority species for recovery by the Recovery of Nationally Endangered Wildlife program. With the new federal Species at Risk Act comes a mandate to formalize recovery plans to reverse population declines for threatened and endangered species in Canada. As part of the process for recovery planning, the Canadian Spotted Owl Recovery Team, supported by Interfor, is working with consultants to develop a spatially explicit habitat supply model that is responsive to various management and population parameters. The Northern Spotted Owl Workshop, hosted by the B.C. Ministry of Sustainable Resource Management, FORREX–Forest Research and Extension Partnership, and the Canadian Spotted Owl Recovery Team, provided a forum for scientists, stakeholders, and decision makers to collaborate in the development of scenarios for the model, the outputs of which will provide management options for the consideration of decision makers.

Specific objectives for the workshop were to:

- Summarize current research on Spotted Owl population demographics and management (British Columbia and United States);
- Identify knowledge gaps and confirm levels of certainty of current knowledge;
- Clarify federal and provincial responsibilities for recovery under the *Species At Risk Act*;
- Clarify socio-economic analysis requirements and approaches for recovery planning;
- Understand the development, uses, assumptions, and limitations of habitat and population models;
- Examine innovative approaches to balancing socio-economic goals through habitat management and enhancement alternatives; and
- Develop habitat and population management scenarios for testing and analysis through the model; the scenario analysis will be a component of a recovery action plan for government's consideration.

These proceedings summarize the various presentations, discussions, and working sessions held at the workshop. The goal of the proceedings is to capture the discussions and information as they were presented at the workshop. Abstracts are presented in the order delivered (see agenda in Appendix A), organized by session. The four sessions of the workshop included:

- What do we know? Gaps, uncertainties, and consensus;
- Understanding models, their uses, and limitations;
- Refining critical questions for the model; and
- Socio-economic analysis and scenario development.

After each session, comments and questions that were addressed to the session panel are noted. In addition, notes that were recorded by the note takers during the presentations are included. All notes have been edited for clarity and grammar.

The views expressed by contributors and participants are their own and are not necessarily those held by the editorial staff, our funding partners, or associated groups. We expect contributors to have taken reasonable steps to ensure that any information or facts quoted or referred to within their abstracts are correct and accurate, do not breach copyright laws, and do not cause offence to anyone. The abstracts and recorded discussions published in these proceedings have been reviewed by Myke Chutter (Spotted Owl Recovery Team–Chair) and Liz Williams (MSRM Recovery Team Member and workshop organizer) for technical accuracy but reviewers did not alter any of the conclusions from the discussion.

Material from the proceedings is not intended to be cited as fact. For factual information, please refer to published, peer-reviewed literature.

As a result of this workshop, participants gained increased knowledge of: the current science around Spotted Owl habitat and population demographics; federal and provincial regulations regarding species at risk: uses and limitations of models: and socio-economic analysis requirements. The modelling team obtained substantial input to, and feedback on, the habitat and population models, resulting in increased understanding and buy-in to the model development process by workshop participants. These results will allow the recovery planning process to move forward with finding solutions to Spotted Owl recovery.

Kathi Zimmerman

Conservation Biology Extension Specialist–FORREX

Kym Welstead

Extension Project Assistant–FORREX

Coffee-break discussions Photo by Rex Turgano

SESSION 1

What do we know?
Gaps, Uncertainties, and Consensus

REQUIREMENTS AND RESPONSIBILITIES FOR SPECIES RECOVERY PANEL

Species at Risk Act (SARA) Overview

DAVID CUNNINGTON AND RICK MCKELVEY*

The content of the *Species at Risk Act* (SARA) overview presentation was drawn from the *Species at Risk Act Guide,* which is available at *www.sararegistry.gc.ca*, and presents this information in more detail.

Concern about the loss of wildlife in Canada is not new. Canadians with an interest in the natural world have noticed and documented the disappearance of certain plants and animals for some time. Public concern for species at risk is broad: for example, polling indicates 90% of Canadians do not want any species to be extirpated or extinct in Canada. In response to this public concern, the Government of Canada signed and ratified the 1992 Convention of Biological Diversity, and has produced a three part Framework for the Protection of Species at Risk. The framework comprises (1) the Accord for the Protection of Species at Risk (the Accord), (2) the Habitat Stewardship Program, and (3) the *Species at Risk Act* (SARA).

The Accord was signed in 1996 by the federal government, and all provinces and territories. Its key provisions include an emphasis on stewardship and a cooperative approach; the precautionary principle that "lack of full scientific certainty must not be used as a reason to delay measures to avoid or minimize threats to species at risk"; agreement to establish complementary legislation to protect species at risk and their habitat; agreement to create and implement recovery plans; and agreement to participate in the Canadian Endangered Species Conservation Council.

Cooperation and stewardship are pre-eminent in the species at risk context. The responsibility for conservation of wildlife is shared between various levels of government. Bodies such as the Canadian Endangered Species Conservation Council, the Canadian Wildlife Directors Committee, and the National Recovery Working Group provide common ground for cooperation, and have developed the various protocols in the national recovery program. The federal Habitat Stewardship Program is the key funding initiative that supports stewardship. It provides $10 million annually across Canada to support stewardship activities on First Nation reserves, private land, and provincial Crown land.

The *Species at Risk Act* is the third component to the national species at risk program—it is the glue that binds all of the elements of species at risk protection in the country together. The federal government shares responsibility for management of species at risk with the provinces and territories, and so SARA has been written to complement various provincial laws such as the British Columbia's *Wildlife Act*, the *Forest and Range Practices Act*, and the *Fish Protection Act*.

We will discuss two of SARA's elements: the listing process, and the protection of species and habitat.

An independent scientific body named the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the status of species in Canada. This organization has been in existence since 1978, and is composed of 29 expert representatives from Canadian universities, provincial and federal governments, non-governmental organizations, and First Nations. The SARA legal listing process begins when COSEWIC assesses the status of a species. The federal Minister of Environment must publish a public response in the SARA registry within 90 days of receiving COSEWIC's assessment, which explains how the government intends to respond to the assessment. The government then has nine months to decide whether the species will be added to the SARA legal list. This two-step legal listing process separates political accountability for adding a species to the list (federal cabinet's responsibility) from the independent scientific assessment of the species' status (COSEWIC's responsibility). The Northern Spotted Owl was included in SARA's initial legal list when the legislation was written.

Once a species has been added to the legal list, it is protected from killing and harassment under SARA's general prohibitions. Its residence (nest or similar structure) is also protected from damage or destruction. Once Critical Habitat (CH) has been defined and published in the public registry, it is also illegal to destroy CH in whole or in part. These prohibitions will be brought into force on June 1, 2004, as the third step in SARA's phased implementation.

The SARA's prohibitions apply first to species on federal lands, aquatic species, and migratory birds. In all other circumstances, the provinces and territories must provide protection using their own laws, as agreed in the Accord (see above). Should a province or territory's laws fail to effectively protect a species at risk, then the federal government has the authority to intervene using SARA's "safety net" clauses. The federal government may also intervene in emergencies by issuing an emergency order, which may prohibit activities that adversely affect species and habitat, and can be applied anywhere.

Finally, SARA also has provisions for permitting activities that affect listed wildlife species if they are on federal land, aquatic species, or migratory birds. Three kinds of activities may qualify for permits: scientific research relating to the conservation of the species, work to enhance the listed species, or activities where harm is incidental.

AUTHORS

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Biography: David Cunnington is the Endangered Species Biologist in the Species At Risk section of the Canadian Wildlife Service's Pacific Wildlife Research Centre. David's responsibilities generally involve implementation of aspects of recovery in the *Species at Risk Act* in British Columbia. He sits on six recovery teams, and is peripherally involved in the South Okanagan Similkameen Conservation Program, and the Garry Oak Ecosystem Recovery Team. He also participates in national working groups such as the National Recovery Working Group, the Residence Working Group, and the Prioritization Working Group. Previously David has worked as a Species At Risk Coordinator for the Prairie and Northern Region of Parks Canada, and a Small Mammal and Herpetofauna At Risk Biologist for the B.C. Ministry of Water, Land and Air Protection. Before he became involved in Canada's Species at Risk program, David worked on diverse programs on rare and endangered species, including surveying bats, amphibians, and reptiles in the

South Okanagan; researching control of an introduced snake that has extirpated 12 bird species from Guam; and investigating the effects of fish stocking on amphibian populations. He has worked and lived in interesting places, such as the Bay of Fundy, Algonquin Park, Point Pelee and Pelee Island, Guam, the South Okanagan, Vancouver Island, and the Canadian prairies.

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Biography: Rick McKelvey is the manager of the Pacific Wildlife Research Centre, Canadian Wildlife Service, Environment Canada. He has been involved with the development of the *Species at Risk Act* for the last 10 years, including development of the regional CWS implementation program, and more recently with development of national policy for its implementation, and the national CWS implementation plan. He has a B.Sc. (1971) and a M.Sc. (1981) both from Simon Fraser University. He has worked on many programs in his career with CWS, including the Pacific Coast Joint Venture, the Fraser River Action Plan, and the Georgia Basin Ecosystem Initiative. Before that he managed the waterfowl program for CWS, and studied the wintering feeding ecology of Trumpeter Swans on parts of the B.C. coast.

Species at Risk in British Columbia: Current and Emerging Provincial Approaches

BRUCE MORGAN*

The Province of British Columbia is seeking an integrated approach to species at risk protection and recovery that provides certainty and predictability for landowners and users and meets national and international commitments. At present, this approach consists of six key elements: implementing the *Forest and Range Practices Act*; conserving and managing parks, protected areas, and conservation lands; completing and implementing land use plans; directing and supporting recovery teams; seeking federal and provincial collaboration; and examining the need to amend provincial policy and legislation.

Consideration of government objectives for endangered, threatened, or vulnerable wildlife is required in forest stewardship, woodlot and range use, and stewardship plans authorized under the *Forest and Range Practices Act*. The B.C. Ministry of Water, Land and Air Protection is the provincial authority responsible for establishing legal objectives for identified wildlife. Forty "elements" (species or ecosystems) are currently identified and another 50 are under consideration.

As landowner and manager for parks and protected areas, the B.C. Ministry of Water, Land and Air Protection has a particular responsibility for protecting those species at risk that occur in these areas.

Provincial land use planning provides opportunities at a variety of scales to incorporate species at risk protection and recovery targets and measures. Current initiatives that are addressing this issue include land and resource management plans, sustainable resource management plans, and the working forest.

Recovery teams are key partners in recovery planning in British Columbia. Currently over 30 teams exist and receive varying degrees of science, policy, procedural, and financial support from the province. Given the importance of the products of these teams in the presence of SARA, the federal and provincial governments are working to better direct and support their activities.

The Province is working closely with the federal government to identify opportunities for achieving certainty and consistency in species at risk protection and recovery. Currently, the Province is supplying input into the development of federal policy that will guide the implementation of key provisions within SARA. British Columbia is also negotiating a bilateral agreement to clearly set out the respective roles and responsibilities of the two governments, clarify the application of SARA in the province, provide certainty of process and due consideration of socio-economic factors as part of species at risk decision-making.

British Columbia is also examining the need for amendments to existing policies and legislation to address the accord and to facilitate collaboration with the federal government as it applies to SARA.

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Biography: Bruce Morgan is the Director of the Biodiversity Branch, B.C. Ministry of Water, Land, and Air Protection. His responsibilities include contributing to the development of species at risk policies, overseeing the development of provincially led recovery plans, and coordinating with the federal government on species at risk programming in British Columbia.

The Canadian Spotted Owl Recovery Team (SORT) in British Columbia

MYKE CHUTTER*

The original Spotted Owl Recovery Team (SORT) was established in British Columbia in 1990 to develop a national recovery plan. In 1994, a management options report prepared by SORT was given to government and released by Cabinet. Following the preparation and release of a socio-economic impact assessment, Cabinet selected an option and created a Spotted Owl Management Inter-agency Team (SOMIT) to develop a management plan for the Squamish and Chilliwack forest districts. The Spotted Owl Management Plan (SOMP) was released as Cabinet policy. The SOMP predicted a 60% chance of stabilization for the Spotted Owl in British Columbia following an initial period of decline. SORT would not endorse this plan, preferring a minimum 70% stabilization option and disbanded shortly after the release of SOMP. The SOMIT (comprising members from the Environment and Forests ministries) were charged with implementing SOMP.

In 2002, the B.C. Ministry of Water, Land and Air Protection (MWLAP) released a population assessment report that suggested that SOMP was insufficient to recover the owl in British Columbia and that extirpation may occur within in 5–10 years unless further action was taken. In October 2002, a new SORT was established by MWLAP.

The roles, responsibilities, goals, objectives, and rules of conduct for the new SORT are outlined in their terms of reference. These include the following:

- The overriding *goal* of SORT is to address the recovery of the Northern Spotted Owl in British Columbia;
- The *role* of SORT is to provide the best available scientific advice on the measures required to recover this species:
    - As raptors in Canada are currently protected solely under provincial legislation, the Province of British Columbia is the lead jurisdiction;
    - SORT reports to the Director of Biodiversity Branch, MWLAP;
    - SORT will operate under the team's terms of reference and in accordance with the Recovery of Nationally Endangered Wildlife (RENEW) Recovery Operations Manual;
    - SORT will provide scientifically sound recovery advice to government and non-government agencies;
    - Decision-making and accountability for making management decisions rest with the responsible jurisdictions.
- The general *objective* for SORT is to develop a recovery strategy for the Northern Spotted Owl that will provide the strategic framework and advice for the recovery and long-term conservation of the species:
    - Upon completion and acceptance by the team, the draft recovery strategy will be submitted to the Director of the Biodiversity Branch;
    - If the strategy concludes that recovery is feasible, SORT will proceed to develop Recovery Action Plans and may designate one or more Recovery Implementation Groups (RIGs) to complete this task;
    - RIGs need to assess and encourage the integration of socio-economic realities into the development and implementation of Recovery Action Plans.
- The *composition* of the team included the following requirements:
    - Responsible jurisdictions must have a member on SORT at all times;
    - Other members may be included to ensure that wide expertise and interest are included;
    - sort members must either have expertise in relevant biological areas and/or represent agencies with legal control over Spotted Owl habitat;
    - The composition of SORT should be sufficiently well-rounded to enable science, management, and stakeholder interests to be considered in its deliberations and advice;
    - SORT will elect a Chair from among its members;
    - The final size of the team is to be determined by team members;
    - Individual team members may choose to designate an alternate for themselves to ensure that their agency or organization is always represented at team meetings.

SORT currently consists of 10 voting members, four alternate members, and a coordinator. Members include the Chair (Myke Chutter) and representatives from:

- B.C. Ministry of Water, Land and Air Protection (Ian Blackburn; Alt: John Surgenor);
- B.C. Ministry of Sustainable Resource Management (Liz Williams);
- B.C. Ministry of Forests (Louise Waterhouse; Alt: Don Heppner);
- Greater Vancouver Regional District (Derek Bonin);
- Canadian Wildlife Service (David Cunnington; Alt: Trish Hayes);
- U.S. Fish and Wildlife Service (Washington: Joe Buchanan);
- Academia (Simon Fraser University: Dr. Alton Harestad);
- Industry (Coast Forest & Lumber Association: Les Kiss; Alt: Wayne Wall, Interfor);
- Environmental community (British Columbia Environmental Network: Andy Miller).

SORT is actively seeking First Nations representation on the team.

The overall objective for SORT is to complete a recovery plan for the Northern Spotted Owl in Canada that includes a recovery strategy and its associated Recovery Action Plans. Under SARA, for newly listed species, one year is allocated to prepare a recovery strategy for an Endangered species which, if recovery is deemed feasible, is to include timelines for Action Plans. However, to address the backlog, the timeline for recovery strategies for species already listed as Endangered on schedule 1 of SARA is extended to three years.

SORT submitted its first draft recovery strategy to MWLAP in November 2003. The environmental non-government organization (ENGO) member does not support the strategy; MWLAP has requested some clarifications before it will be accepted. The draft strategy concludes that recovery is ecologically and technically feasible, but cautions that substantial funding and recovery efforts are needed immediately, and that success cannot be guaranteed. Upon acceptance by MWLAP, the draft will be released for full agency, public, peer, and stakeholder review. Review comments will be evaluated and incorporated as deemed appropriate by SORT , following which a final draft will be submitted to MWLAP. Upon acceptance of the final strategy, it will be posted on the RENEW Web site.

SORT is using the draft strategy as a framework and has begun work on Action Plans for Habitat, Population (inventory and augmentation), and Funding and Communication. SORT recognizes the importance of population and habitat modelling as a key component of the action planning process, and is pleased to co-host this workshop.

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Biography: Myke Chutter, R.P.Bio., graduated in zoology from UBC in 1976. From 1977 to 1981 he worked as biological assistant for Donald A. Blood and Associates, conducting wildlife surveys (mostly on birds) in British Columbia, Yukon, and Saskatchewan. In 1981 through to 1991, Myke joined the B.C. Wildlife Branch in Nanaimo as part of their 10-year Integrated Wildlife-Intensive Forestry Research (IWIFR) deer project crew. During this time he worked mostly on a black-tailed deer telemetry /habitat-use research study, but also worked on wolves, elk, marmots, swans, and geese. From 1991 to present, Myke transferred to Victoria where he became the provincial Bird Specialist. In British Columbia's senior technical position for bird management, he represents the province on various international, national, and provincial committees. The Bird Specialist's responsibilities include setting avian policy/ procedures, harvest regulations, and working on species at risk issues. In 2003, Myke became Chair of the Spotted Owl Recovery Team, which is preparing a recovery plan comprising a Recovery Strategy and associated Recovery Action Plans for Spotted Owl in British Columbia.

Comments and Questions Concerning Requirements for Species Recovery

Q: *What was it about the draft strategy that the non-government organizations (NGOs) did not agree with?*

C: This question was not addressed as it was not the appropriate forum to discuss this issue. The questioner was directed to the NGO representative in the room for a direct response.

CRITICAL HABITAT OVERVIEW

Critical Habitat under SARA

DAVID CUNNINGTON AND RICK MCKELVEY*

Critical Habitat (CH) policy in the federal government is currently under development. The following presents the current state of thinking on CH: however, the concept and application of CH remain a work in progress.

Critical Habitat is defined in SARA as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in a recovery strategy or in an action plan." Ultimate responsibility, accountability, and discretion to identify CH rest with the Competent Minister (the federal Minister of Environment in the case of the Spotted Owl). The recovery strategy and action plans are reviewed and approved by the provincial government, and the recovery team is responsible for producing scientific advice on CH using the best available evidence.

SARA makes it an offence to destroy CH in whole or part. On non-federal land, or for non-federal species, the provinces and territories have the first opportunity to protect CH, in fulfillment of the Accord for the Protection of Species at Risk agreement to protect habitat for threatened and endangered species. If the Competent Minister under SARA believes that the laws of a province do not effectively protect CH, the minister must recommend to Governor in Council that SARA's CH safety net measures be invoked. The current interpretation of "effective protection" is that protection measures and mechanisms exist that can reasonably be expected to abate threats to CH. The goal of "effective protection" is maintenance of function of the habitat, and does not necessarily entail the level of protection granted by areas such as parks. Section 10 and 11 "conservation agreements" will likely be an important tool for effective protection of CH.

There is no "cook book" approach to the definition of CH, and the process is open to customization for individual species. However, CH definition contains a few key elements, and a five-step process that incorporates these elements is currently envisioned as:

1. **Define biophysical attributes**
   The recovery team is responsible for defining biophysical attributes in step 1. They may consider any number of factors, such as biotic and abiotic parameters, temporal considerations, and landscape scale issues such as connectivity and habitat complementarity.
2. **Locate potential habitat**
   In step 2, the recovery team locates potential habitat, including future habitat that may be created by restoration, succession, or enhancement.

3. **Rationalize habitat against recovery goal**
   In step 3, the recovery team rationalizes habitat against the recovery goal. This may include the use of analytical tools such as population viability analyses. The team also determines what proportion of the habitat is to be protected, and identifies threats to this habitat. The team may also analyze stakeholder views, practical limitations, and other factors.

4. **Competent Minister determines CH**
   In step 4, the Competent Minister considers the team's advice from step 3, in combination with implementation factors, and creates the definition of CH.

5. **Formal CH identification in the published Action Plan**
   Step 5 is the formal identification of CH, and is the responsibility of the Competent Minister. Identification may include explicit mapping, or a written description of the attributes (biophysical and functional) and general locations.

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Biographies: See page 4

Comments and Questions Concerning Critical Habitat

C: Regarding "protection measures and mechanisms that can reasonably be expected to abate threats to Critical Habitat," there is some dependence on the recovery teams to help define what "can reasonably be expected". SARA has been constructed to allow for this kind of flexibility. The federal government representatives on the recovery team are responsible for informing the recovery team members about SARA requirements and policy to ensure that recommendations are developed that are acceptable to the Minister.

Demographic Status of the Spotted Owl in Washington

JOE BUCHANAN*

No abstract was provided. For more information on this subject please contact the author.

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Options for Enhancement, Restoration, and Maintenance of Spotted Owl Habitat

DALE HERTER*

Spotted Owl sites were monitored and surveyed in the central Cascade Range of Washington State from 1990 through 2003. From 1992 to 2003, the Spotted Owl population on the study area decreased by 70%. This decrease parallels data from nearby study areas in Washington. Habitat changes cannot account for the decline. Invasion by a competitor, the Barred Owl, from eastern North America is thought to be responsible for most of the decrease in Spotted Owl numbers. As of 1993, there were approximately equal numbers of Barred Owl territories as Spotted Owl territories in the central Washington Cascades. By 2003, Barred Owl sites were thought to have increased across the study area at the expense of Spotted Owl sites.

Productivity of Spotted Owls appears to be affected by climatic gradients caused by the rain shadow effect in the Cascade Range as revealed by vegetation zones. Spotted Owl territories in the driest occupied zone of the eastern Cascade Range were over 3 times more productive than territories in the wettest zones on the west side of the range. Mortality rates of adults, however, were almost double in this driest zone when compared with the wettest zones. Causes of clines in productivity and mortality probably relate to prey density and diversity and predator densities, respectively; however, data on these causative factors are scant. Landscape types also appear to affect productivity. Owls nesting in landscapes with some opening (clearcuts) produced more young on average than owls in wilderness/ national park landscapes with few major openings in mature/old forest cover. While unsustainable overharvesting can cause abandonment of a landscape by Spotted Owls, some openings in the forest cover appear to bolster productivity.

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Biography: Dale Herter is a wildlife biologist with Raedeke Associates, Inc. in Seattle. He has been surveying and studying Northern Spotted Owls for the past 14 years. Studies have included annual monitoring of 60 Spotted Owl territories in the central Cascade Range, radio-telemetry studies of home range and habitat use, studies of prey populations, and participation in the modelling procedure to predict habitat for Spotted Owls on the Plum Creek Habitat Conservation Plan area. He manages the database for the Rainier Demography Study Area, one of 14 study areas across the range of the Northern Spotted Owl, and used to assess the status of the population every five years.

Précis of the Northern Spotted Owl in British Columbia

ALTON HARESTAD, JARED HOBBS, AND IAN BLACKBURN*

The Northern Spotted Owl (*Strix occidentalis caurina*) is a subspecies of Spotted Owl that occurs from northern California, through western Oregon and Washington, and into British Columbia. Two other subspecies occur elsewhere in California, southwestern United States, and Mexico. In Canada, the Northern Spotted Owl is confined to the southwestern mainland of British Columbia where its range, based on known and historic records, covers approximately 32,830 km^2. In the west, this subspecies extends from the Lower Mainland north along the Squamish River valley, and across the Lillooet River valley northwest of the town of Pemberton to approximately Downton and Carpenter lakes. In the east, the Northern Spotted Owl occurs from the Canada–U.S. border in Manning Provincial Park, north through the town of Lytton, and reach the limit of their range near the town of Lillooet.

The Northern Spotted Owl is not currently distributed evenly across its range in British Columbia. Gaps occur in its distribution; for example, the Lower Mainland and the western portion of the Squamish Forest District have historic records but no recent sightings. As well, some remote areas have not been systematically surveyed. Other portions of its range appear to have concentrations of sightings (e.g., the Pemberton to Lillooet area and Chilliwack Lake north through the Fraser Canyon and associated watersheds). The distribution of records reveals possible routes of connectivity among Spotted Owls in British Columbia and also between British Columbia and northern Washington.

The Northern Spotted Owl is a red-listed subspecies in British Columbia. It was designated Endangered by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1986 and this status was reaffirmed in 2000. As well, this subspecies is designated Endangered under the *Species at Risk Act* (SARA).

Partly in response to the earlier designation, initial surveys of Spotted Owls were conducted beginning in 1985. Then between 1992 and 2001, more intensive and standardized surveys were conducted at 147 areas in the Chilliwack and Squamish forest districts. Search effort varied among years, hence, some areas were not surveyed annually. Spotted Owl surveys were conducted at night using acoustic lures (call playbacks) at stations along transects within each survey area. Owl calls were broadcast at each station to elicit territorial responses. A cumulative frequency distribution was derived for the nighttime search effort required to detect the first Spotted Owl each year in each of 40 survey areas between 1992 and 2000. This distribution was used to determine a criterion for estimating the likelihood that Spotted Owls were absent from other individual survey areas. A minimum 13 hours of unsuccessful nighttime search effort was used to indicate a 90% chance that a surveyed area was vacant. Forty of the 147 survey areas were used to assess the current trend in numbers of Spotted Owls. Only survey areas that were occupied at least once by a territorial Spotted Owl during the study were chosen. This ensured that the local habitat could support owls. As well, only survey areas that had sufficient survey effort to assess changes in occupancy during the study period were chosen for the trend assessment.

The annual percentage occupancy of Spotted Owls within the 40 survey areas was estimated between 1992 and 2001 and used an index of relative abundance. Within these survey areas, Spotted Owl occupancy declined by 49% during this 10-year period at an average annual rate of decline of -7.2%. The 2002 surveys indicate the population declined perhaps by an additional 35% between 2001 and 2002 (i.e., the estimate in 2002 was 65% of that in 2001). Including these data, the Spotted Owl population in British Columbia declined by 67% between 1992 and 2002 at an average rate of 10.4% per year. If we assume that the study area is representative of the entire Spotted Owl population in British Columbia, then the number of Spotted Owls in British Columbia has declined sharply over the past 11 years. The population of Spotted Owls was estimated to be fewer than 100 breeding pairs in 1991. If the 1991 estimate was correct, the decline observed between 1992 and 2001 suggests that the current Spotted Owl population in British Columbia during 2001 was fewer than 50 breeding pairs. Data from 2002 suggests that the current Spotted Owl population in British Columbia may be fewer than 33 breeding pairs.

Adult survivorship and reproductive success is related to the amounts of suitable habitat within an owl's territory. In the areas surveyed in British Columbia, the population decline was estimated from a sample of owls whose territories contained on average 62% suitable habitat at the gross landscape scale. The amount of suitable habitat in the survey areas did not change substantively during the 10-year period, although timber harvesting continued in other portions of the three forest districts within which Spotted Owls occur. Part of the decline in abundance of Spotted Owls in British Columbia can be attributed to loss and fragmentation of old forest habitat within the owl's range over the last century. Increased fragmentation of habitat at the landscape level can diminish survivorship of juveniles during their dispersal and would reduce their recruitment to the population. Other factors may have also contributed to the decline. These include competition with Northern Barred Owls (*Strix varia varia*), inclement weather, lower prey populations, and increased predation. Northern Spotted Owls are, in part, susceptible to the adverse effects of these factors because they have low juvenile survivorship and low fecundity.

The Spotted Owl population in British Columbia is very small and vulnerable to stochastic events that could cause further population declines, and perhaps even extirpation. If the population of Spotted Owls were larger, it would be more resilient to these stochastic events. Efforts to protect suitable habitat, and perhaps enhance habitat, are necessary for the long-term recovery of the Spotted Owl in British Columbia.

Acknowledgements: Information used in this summary and perspectives about Spotted Owls in British Columbia and Washington were derived from the work of the Spotted Owl inventory field personnel and staff from the B.C. Conservation Foundation, Dave Dunbar, Myke Chutter, Brian Clark, Laura Darling, Lian Duan, Eric Forsman, Dave Fraser, Shawn Hilton, John Surgenor, Ross Vennesland, and the Spotted Owl Research and Inventory Advisory Committee. Habitat Conservation Trust Fund, Forest Renewal B.C., Corporate Resource Inventory Initiative, Land Use Coordination Office, B.C. Ministry of Environment, Lands and Parks, B.C. Ministry of Forests and the forest companies and their staff in the Chilliwack and Squamish forest districts provided funding and logistical support.

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Demography of Spotted Owls in British Columbia: Information Gaps and Hypotheses

KEITH SIMPSON*

The life history of B.C. Spotted Owls may be substantially different from southern birds due to our location on the northern edge of the range. Spotted Owls have been surveyed in British Columbia since 1985. Thirty nine occupied sites were identified up to 1993. Information is needed on nesting frequency, fecundity, survivorship, and movements to characterize the population. From 1985 to 1993, 71 different owls were detected; since then 16–35 birds have been detected annually. Eight nest sites have been found and 12 breeding pairs with a maximum of 2 juveniles found per year from 1992 to 2001. Telemetry data from 8 banded birds indicate that home ranges during the breeding season are similar to southern populations (800 ha) but annual home ranges may be much larger than expected (5–12,000 ha). Four of the 12 successful nests were in coastal habitats and 8 were in interior transition habitats. Some banding, food habits, habitat characteristics, and nest success data were collected but has not been reported.

Hypotheses that should be explored using local data are that, compared with southern populations, B.C. Spotted Owls:

- have a smaller more dispersed population;
- suffer higher mortality;
- have larger ranges and move around more to facilitate finding prey and mates;
- produce fewer young at longer intervals;
- require higher quality habitat to facilitate successful reproduction.

This information will be essential to design an effective recovery strategy for B.C. owls. Relying on parameters collected from populations to the south, without local confirmation, may overestimate the capacity of B.C. habitats to support Spotted Owls and result in an inadequate management approach.

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Biography: Keith Simpson is a Registered Professional Biologist born, educated, and practicing in British Columbia. He completed his B.Sc. thesis on black-tailed deer at SFU and his M.Sc. thesis on Great Blue Herons at UBC. He has previously worked for the B.C. Fish and Wildlife Branch, the Canadian Wildlife Service, and the Department of Fisheries and Oceans. He co-authored the *Provincial Standards for Ungulate Aerial Inventory, Wildlife Habitat Assessment, and Radio Telemetry* and prepared the provincial training course for wildlife species inventory. He has been a consulting biologist at Keystone Wildlife Research Ltd. for 20 years and had the privilege of working on several long-term research studies of moose, deer, elk, caribou, and grizzly bear for four major hydro-electric and highway developments. Keith applies his knowledge and experience to assess the impacts of mining, forestry, and agriculture on wildlife and to help provide integrated management solutions for government and industry throughout British Columbia.

Comments and Questions Concerning Demographics

C: There are issues associated with juvenile Spotted Owl survival and recruitment into the adult population – **Q:** *How well are chicks doing in more open habitats?* **Q:** *Do clearcut areas temporarily increase the prey base?*

C: The problems with low survival of juveniles may be related to Barred Owl competition in Washington State – juvenile survival is lower when compared with areas further south. More southern areas do not have problems with Barred Owl competition.

C: The effect of the checkerboard landscapes on Spotted Owl social function and productivity is unknown. These differences may influence home range and corridor size.

Q: *What are the differences between coastal versus interior birds in British Columbia? (e.g., food source, nesting frequency/success, territory size?)*

C: The natural fragmentation of our landscape in British Columbia reduces that ability to provide continuous cover and connectivity–large corridors may help.

HABITAT MANAGEMENT OVERVIEW PANEL

Habitat-based Management for the Spotted Owl in Northern Washington

JOE BUCHANAN*

No abstract was provided. For more information on this subject please contact the author.

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An Overview of the Spotted Owl Management Plan (SOMP) in British Columbia

MYKE CHUTTER*

The Northern Spotted Owl is declining throughout its range from British Columbia to California. It is designated as Threatened under the U.S. *Endangered Species Act,* Endangered in Canada by COSEWIC, and is red-listed in British Columbia. It was declared Canada's highest priority species for recovery by RENEW in 2001.

In British Columbia, raptors come under provincial jurisdiction. Section 34 of the provincial *Wildlife Act* protects all native birds, their young, eggs, and nests. The provincial Forest Practices legislation protects red- and blue-listed species, including the Spotted Owl, under its Identified Wildlife Management Strategy. The federal *Migratory Birds Convention Act d*oes not cover birds of prey (owls, eagles, hawks, falcons); however, the federal *Species At Risk Act* can extend protection to COSEWIC-listed species, including the Spotted Owl (which is listed on schedule 1 of the Act).

The history of Spotted Owl management in British Columbia began in 1985 when the first inventories were conducted. In 1986, the owl was designated Endangered in Canada by COSEWIC, and in 1989 it was provincially red-listed in British Columbia. A recovery team was established in 1990 and an interim conservation strategy was prepared in 1993. In 1994, the recovery team's option report was released, followed in 1995 by provincial socio-economic impact assessment report. In 1995, the B.C. government chose an option and created the Spotted Owl Management Inter-agency Team (comprising representatives from the Environment and Forestry ministries) to develop a management plan for the Squamish and Chilliwack forest districts. In 1997, the Spotted Owl Management Plan (SOMP) released as Cabinet Policy.

The SOMP option chosen predicted 60% chance of stabilizing the owl's population in British Columbia over 100 years, following an initial decline. It limited protection only to those sites known to 1995. As a result, it was not endorsed by the recovery team which would not accept an option that predicted less than a 70% chance of stabilization.

SOMP includes 363,000 ha of forest habitat in the Chilliwack and Squamish forest districts; 44% in protected areas, 56% in Crown forest in the timber harvesting landbase. Areas managed for Spotted Owls are divided into 21 Special Resource Management Areas (SRMZs) which are further subdivided into 101 Long-Term Activity Centres (LTACs). Each LTAC represents the approximate home range of one pair of owls (~3,200 ha), of which 67% is to be maintained as suitable habitat. However, due to logging history of the area, 44 of the 101 LTACs are below 67% suitability and require habitat recruitment. In addition, the plan created several Matrix areas. Matrix areas are temporary reserves that will be phased out over 50 years as habitat in LTACs is recruited. Harvest is allowed within the two forest districts outside LTACs, and within LTACs with greater than 67%; some silvicultural removal is allowed in LTACs for enhancement purposes. The SOMP does not include protection for 19 occupied sites discovered since 1995: 11 in the Chilliwack/Squamish forest districts, and 8 in the Cascades Forest District.

Recent population trend analyses suggest that the population is declining at a greater rate than the SOMP model predicted and that SOMP may be insufficient to conserve the species in British Columbia. Loss and fragmentation of habitat, and competition from Barred Owls are considered the greatest threats to recovery.

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Spotted Owl Management Plan–Resource Management Plans

GENE MACINNES*

The provincial government approved the Spotted Owl Management Plan (SOMP) in May 1997 "to provide for a reasonable probability that the Spotted Owl population would stabilize and possibly improve its status over the long term without significant impacts on timber supply and forestry employment." The SOMP relies on 21 Special Resource Management Zones (SRMZs) ranging from 10,000 to 30,000 ha throughout the range of the Spotted Owl within the Chilliwack and Squamish forest districts. Of the approximately 363,000 ha of forested area included in the plan, about 159,000 ha exists in parks and protected areas while the remaining 204,000 ha is provincial Crown forests.

In the development of the SOMP it was apparent that to achieve the objectives of the plan on the ground, further definition of the strategies and objectives would be required. Resource Management Plans (RMPs) were developed over a two-year period (1997–1999) to meet this requirement and was done as a collaborative effort between the forest industry; the B.C. Ministry of Water, Land and Air Protection; and the B.C. Ministry of Forests. The RMPs have two basic objectives: (1) to meet Spotted Owl habitat management objectives at the strategic and stand levels, and (2) to meet the social and economic objectives of SOMP.

An RMP was completed for each of the SRMZs that were located in the provincial Crown forests where industrial forest activities would occur. The SRMZs were divided into smaller units of long-term activity centres of approximately 3,200 ha. Each SRMZ would therefore contain between 3 and 10 long-term activity centres. A total of 67% of the forests over 100 years old were then identified as long-term owl habitat. The remaining 33% of the long-term activity centres were identified as forest management areas.

To guide the development of the RMPs the most recent information on Spotted Owl and forest inventories were used. The Spotted Owl inventory was used to identify critical nesting and roosting habitats and long-term critical habitats. The forest cover inventory was used at the strategic level to identify Type A and B habitats within the landscape. Other criteria used in the determination of long-term owl habitat included items such as patch sizes greater than 500 ha, linkage corridors greater than 1 km wide to connect other long-term activity centres within the SRMZ and a target of 50% Type A habitat.

To meet the socio-economic component of the SOMP, the design of the RMPs targeted areas that already had various levels of harvesting constrained through other processes. Areas such as environmentally sensitive areas, inoperable forests, visual management areas, and other Forest Practices Code constraints were used as an overlap for Spotted Owl habitat.

RMPs demonstrate how, over a long-term planning horizon of one or more forest rotations the SOMP OBJECTIVES will be achieved in each SRMZ. The RMP is based on the best available Spotted Owl ecology information, management approaches, and professional judgement. It is expected that the RMP and associated management practices will need to adapt, as new information becomes available. The adaptive management approach will be used to improve the protection of Spotted Owls while improving the economic efficiencies and effectiveness of forest management operations within the Spotted Owl areas.

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Biography: Gene MacInnes, RPF, has worked for the B.C. Ministry of Forest since 1975 and has held a variety of positions. He has been fortunate to spend most of his career in the Chilliwack Forest District, working in silviculture, resource use planning, and First Nations relations. Gene presently holds the position of operations manager. He has worked on the Spotted Owl topic since 1992. Gene was a member of the interagency team that wrote the Spotted Owl Management Plan, which was approved in 1997. Between 1997 and 1999, Gene was part of the team that developed the resource management plans. Gene graduated from the College of New Caledonia.

The Spotted Owl Management Plan: On the Ground Experiences

BILL ROSENBURG*

Could the interests of the owl and the needs of the forest industry both be accommodated through the application of the Spotted Owl Management Plan (SOMP)? The industry was initially apprehensive when the SOMP was released in 1997. However, changing practices in forest harvesting led to the adoption and application of the SOMP.

Planning requirements for operations in owl areas were increased immensely from non-owl areas. The SOMP allows for two types of harvesting: light volume removal (LVR) and heavy volume removal (HVR). The HVR proved to be manageable, as it closely resembled variable retention harvesting which Interfor was practicing throughout its operations. The LVR was much more challenging as it only allowed for a 30–40% removal of the stand.

One of the biggest challenges for implementation was the interpretation of the guidelines to actual on-the-ground practices. Several field trips with agency staff provided some insight but Interfor foresters made their own interpretation in the actual application. Post-harvest field trips with members of the Spotted Owl Recovery Team confirmed that habitat conditions were improved.

The current guidelines as taken literally are simply too restrictive to achieve a safe logging operation. The width yarding corridors prescribed in the guidelines are unrealistic. The maximum allowance of 7 m was found to be the actual natural tree spacing. Once a narrow corridor was created, it was closer to 10 m wide. Considerable time was spent marking leave trees. Interfor found out in the supervision of the fallers that tree marking could have been forgone, as a forester was on site continually during the falling phase to advise on substitutions of marked trees.

A big issue at the operational level is worker safety. This topic receives little mention in the guidelines, which is a serious shortcoming as safety is a prerequisite for any operational activity. Interfor worked with the WCB to develop safe work procedures to provide guidance to workers on the ground. The falling phase was the most problematic and required constant one-on-one supervision. All of Interfor's trials were conducted with no safety infractions.

Interfor's experiences indicate that HVR closely mimics current variable retention harvesting and is operationally feasible. LVR if applied in favourable conditions can be operationally feasible. Foresters must be given the ability to interpret the guidelines to meet local conditions. Without this flexibility the current guidelines are too restrictive. Interfor has withdrawn from harvesting in Spotted Owl areas until the government provides clear direction on population numbers and well-defined acceptable practices.

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Comments and Questions Concerning Habitat Management

C: Overlapping species at risk should be integrated into the recovery planning process as Spotted Owls may act as an umbrella species.

C: There should be integration of present and emerging management plans. A five-year review is being completed by the U.S. Fish and Wildlife Service—we should follow this example.

C: There is an indication that habitat is the driver behind the Spotted Owl decline but other factors may be causing declines that need to be considered and assessed as part of an adaptive management process.

Q: *Are there any post-harvest assessments to ensure correct amounts of habitat are retained?*
A: Harvesters generally leave more than what is recommended, therefore assessments not usually conducted.

C: Landscape-level planning for the future – we want to start at the landscape level and then narrow down to the stand level. On-the-ground information is needed to initiate changes in forest management. Planning should be at the landscape level.

C: There are long-term forest management plans for Spotted Owl in British Columbia.

MODERATOR'S SUMMARY FOR SESSION 1

What Do We Know? Gaps, Uncertainties, and Consensus

JOHN INNES*

The conservation of the Spotted Owl is clearly an issue: 90% of Canadians do not want any species to be extirpated or extinct in Canada, and RENEW in 2001 identified the Spotted Owl as Canada's highest priority species for recovery. If provincial legislation fails to protect a species effectively, the federal government has the authority to intervene. The earlier (1990) Spotted Owl Recovery Team did not endorse the 1997 Spotted Owl Management Plan as it only had a 60% chance of population stabilization (the plan was subsequently considered by the B.C. Ministry of Water, Land and Air Protection to have the potential to result in extirpation of the Spotted Owl in Canada within 5–10 years). A recovery strategy drafted by the new (2002) SORT concludes that recovery is ecologically and technically feasible, but the details of the plan have not yet been made public. Modelling will play an important part in choosing appropriate scenarios for recovery, and this workshop was aimed at identifying some of the gaps, uncertainties, and consensus about the knowledge that could be used for the models.

Knowledge Gaps:

A number of knowledge gaps and uncertainties identified in this session are summarized below:

Washington

- There are knowledge gaps over the range of the species, its interactions with the Barred Owl, home range size, the amount of habitat used, the relationships between habitat structure and prey populations, dispersal and recruitment, and the overall status of the species in northwest Washington.

- The causes of a 70% decline in Spotted Owl populations in the central Cascade Range between 1990 and 2003 are uncertain, but the Barred Owl is believed to be largely responsible.

British Columbia

- There is lack of systematic, reliable monitoring of Spotted Owls in the area immediately to the south of British Columbia
- Information on the occurrence of Spotted Owls in British Columbia is lacking, and records are likely going unreported.
- There are gaps in our knowledge of adult survival rates, nesting frequency, fecundity, juvenile survival, dispersal, genetic distinctiveness, ecological distinctiveness, mortality factors, and the habitat quantity and/or quality that drives the choice of nest sites.
- There are knowledge gaps over the extent of annual movements, year-to-year changes in territories, the geographic limit of successful reproduction, and the geographic limit of occupied territories.
- Differences in the choice of prey between coastal and interior birds are not fully known.
- We do not know whether there are differences in territory size between interior and coastal birds.
- We do not know how topographic and habitat barriers operate. Are mountains a barrier to movement? To what extent does the Fraser Valley represent a barrier?
- We have little information on Barred Owls. Are they competing against B.C. Spotted Owls? What are the home ranges and dispersal of Barred Owls?
- We need information of the role of habitat in dispersal of Spotted Owls.
- We do not know why the species is declining.
- We do not know whether the silvicultural adaptations that have been undertaken specifically for Spotted Owls are having any effect on Spotted Owls.
- There is a need to document habitat on both sides of the Canada–U.S border and to determine whether owls cross the border.

Uncertainties

- What is meant by "effective protection"?
- How useful is juvenile survival data in calculating lamda values?
- Are the extrapolations used to identify population trends in British Columbia valid?
- Is there really a decline in the B.C. Spotted Owl population? How can we say this when we are uncertain of its overall range in British Columbia?
- Is a plan that allows for a 60% chance of survival reasonable, especially when the population is considered to be declining at a greater rate than the plan model predicted?
- What are the roles of forest openings in determining population dynamics? Is a checkerboard habitat pattern, as occurs in the United States, good or bad?
- How important is habitat change in relation to other factors that might be influencing Spotted Owl populations?

Other Issues

- There is a lack of centralization of information in British Columbia, and a lack of information sharing between the different stakeholders.
- Are there gaps in provincial legislation and, if they exist, will they be rectified in time to save the Spotted Owl from extirpation in Canada?
- Why is there no formal data collection plan? Why is there no central repository of information for this species?

- Information management seems to be a major issue with the Spotted Owl. Is government the best place to act as a repository? How can information about Spotted Owls better be incorporated into management actions? An appropriate organization needs to be given the mandate to take on responsibility for these actions.

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Session 2

Understanding Models, Their Uses, and Limitations

PROPOSED HABITAT/POPULATION MODEL FOR BRITISH COLUMBIA

A Framework for Assessing Consequences of Alternative Management Scenarios on Spotted Owl Habitat and Prospects for Population Recovery in British Columbia

GLENN D. SUTHERLAND, S. ANDREW FALL, AND DAN O'BRIEN*

The Canadian (British Columbia) population of the Northern Spotted Owl (SPOW), dependent on old-growth forests and heterogeneous stand structures for habitat, is in apparent decline, although reasons for the decline are not well understood (Blackburn et al. 2002). The federal *Species At Risk Act* (SARA) mandates that development of "recovery plans" for endangered species must consider all stakeholders directly implicated by recovery of the species, broad public awareness and consultation, habitat stewardship and protection strategies, and socio-economic factors (RENEW 2003). To assist development of their recovery plan, the Canadian Northern Spotted Owl Recovery Team (SORT) is using a stochastic and spatially explicit landscape management/habitat/population projection framework for assessment of habitat management and population recovery scenarios.

In this presentation, we describe the design and implementation of this analytical framework (Figure 1) to aid decision-making and recovery strategy planning for this species. In contrast to more frequently used organism/population-focused approaches to population viability analysis, this modelling framework follows a management/habitat-focused approach, which focuses directly on the decision-making process from the outset and is designed to provide information that is directly usable by managers and decision makers. The key questions this framework is designed to help answer are:

How likely is recovery of the B.C. population, given the present and future state of the population, habitat, and uncertainties in each of these?

- If recovery is not possible within a reasonable time frame, then what is the likelihood of recovery at a given point in time under different habitat conservation and enhancement options that would enhance connectivity with the regional population?
- What other conservation options are feasible?
- What SPOW conservation policies can and should be considered at different stages of land management planning (e.g., higher-level planning, Timber Supply Review, operational)?

Although the framework has many components, each one is implemented as a relatively autonomous and simple submodel. Its central components are:

1. A *landscape projection submodel* that implements natural disturbance dynamics, forest growth, probable species succession trajectories, and forest management policy (including harvest and

road construction) to project indicators of the forest state (age, species composition, green tree volumes) over time.

Stand-replacing natural disturbance dynamics (fire/insect outbreaks) are parameterized from empirical estimates of annual disturbance patch size distributions and return intervals in the wet and dry subregions of the species range in British Columbia. Silvicultural management policies are implemented by a spatial timber supply model (STSM) that projects indicators of economic activity (e.g., harvest volumes, road development) as well as locations of harvest blocks and roads in response to economic and ecological objectives;

2. A *spatial habitat classification submodel* that uses a neighbourhood resampling algorithm to classify habitat into four types (nesting, foraging, dispersal, and unsuitable) based on mapped topographic and projected stand structure attributes, given the spatial requirements of the species.
3. A *spatial stage-based population submodel* that represents three stages of the SPOW life cycle: juveniles, non-breeders (subadults or non-breeding adults), and breeding adults, together with recruitment and mortality rates. Parameters for the population model are derived from occupancy and telemetry data from British Columbia, as well as long-term demographic and habitat association data from the Pacific Northwest (particularly Washington State). In this submodel the amount and distribution of available habitat at each time step directly influences the population's

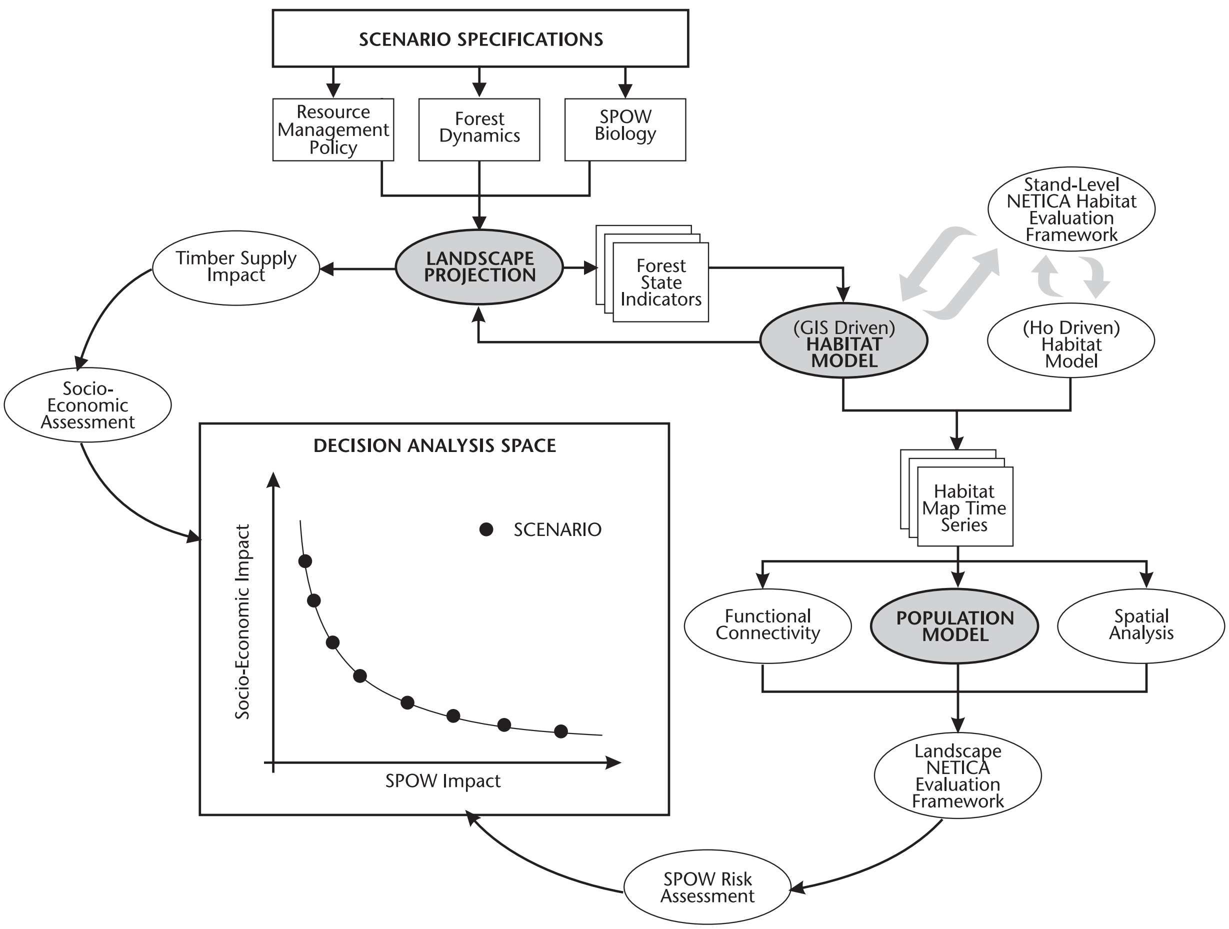

FIGURE 1 Recovery planning and assessment framework for the Northern Spotted Owl (SPOW) in British Columbia. Shaded ovals indicate core model components described in this abstract. Except where noted, all components are constructed using SELES (Fall and Fall 2001).

vital rates by (1) determining location of potential active sites within nest habitat; (2) determining the viability of existing active sites based on the proportion of suitable habitat within the territory; and (3) determining dispersal capability (i.e., least cost paths), and habitat specific dispersal mortality rates. In addition, we use functional connectivity analysis (based on dispersal and movement patterns of the species) and spatial analyses of forest structure to assess degree of connectivity of SPOW activity areas (known or potential), and to identify priority habitat areas that strongly influence flows of individuals within the species range in British Columbia and with the population in Washington State. The population submodel projects indicators of population status, as well as probabilities of achieving a given recovery goal over a specified time period.

Results of habitat management objectives and population scenarios are assessed using a post-projection probabilistic analysis submodel using the Netica™ Bayesian Belief Network software. The consequences of different scenarios on the likelihood for SPOW recovery in British Columbia can be evaluated to help design plausible recovery strategies. They can also be linked to other socio-economic assessment models (South and Farenholtz, this volume) to assist in the selection and implementation of a feasible recovery strategy.

Complexity, uncertainty, and tight timelines ensure that landscape scale resource management decisions are inherently difficult to make (Eng, this volume). Because biological complexity and uncertainty clearly dominate the analysis of SPOW recovery options in British Columbia, we propose a two-stage scenario evaluation process using this evaluation framework: (1) experimental "learning" scenarios to understand system responses across a wide range of plausible ecological and policy situations; and (2) more focused "policy" scenarios that evaluate the probabilities of achieving recovery goals under implementable management options.

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Comments and Questions Concerning Proposed Model

C: The model takes large water bodies and other natural Spotted Owl barriers into account. This is the hardest to input into the analysis. It is known as an impedance value surface. A function is written for a natural Spotted Owl barrier (e.g., water bodies, lakes, alpine). Each barrier at this point has the same relative impedance. The modellers need to know if they are different.

C: When modelling the spatial distribution of patches (i.e., assuming the movement of owls is random versus assuming they know the spatial distribution), we need to test hypotheses associated with questions such as: What is the likelihood of a Spotted Owl stopping along the way?

C: Model credibility by the public: the model needs to be communicated to stakeholders and the public as a credible process to allocate land and make decisions by incorporating as much hard science as is available. One approach to increasing model understanding is to have the submodels loosely coupled. The other approach is to develop them collaboratively, making the general methods available to the public. It is important to guide people through the model and try to make it as simple as possible.

C: It is difficult to build public trust in the credibility of the model when it is complex and hard to interpret (SELES is a complex model). **Reply:** SELES breaks down into basic elements and is not that difficult to interpret. Need to start complex and work our way down to the essential variables.

C: Regarding forest cover database accuracy and ground truthing, it is important to be honest about the data inaccuracies or unreliability and ask users to do their own field checks.

C: It is critical that, given certain assumptions, the model can capture the relative likelihood of outcomes.

C: Modelling can be linked to other analyses (e.g., timber supply analysis).

C: Models need to be a balance between simplicity and complexity, and should be jointly crafted with partners.

C: One topic that has not been examined is the potential sensitivity of birds to air pollutants.

LANDSCAPE-LEVEL HABITAT MODELS AND POPULATION MODELS PANEL

Landscape Modelling: Limitations, Applications, and Parameterization

KEVIN MCKELVEY AND SAMUEL CUSHMAN*

We now have a long history of industrial computer model (automobile crash models, aerodynamics models, etc.) development. These models are based on well-understood principles, and can be tested. Crashing an automobile into a wall provides both a direct test of the car, and of the computer models that were used to help design the car. In many cases these models have been tested and validated literally thousands of times. Even though these models have every advantage, they are still not trustworthy enough to be used without direct confirmation; companies still crash cars or build full-scale replicas in wind tunnels. Comparatively, ecological models have many disadvantages; the underlying dynamics are more complex and are less understood, and, most importantly, the models are generally not testable. The idea that an ecological model will give a precise, reliable output, when this goal is elusive for engineering models is clearly mistaken. Nevertheless (and precisely because we cannot test most ecological models), we are even more dependent on them. We do not have any alternatives for projecting future conditions.

Given this, we need to build and use models playing as much as possible to their strengths, and avoiding their weaknesses. Models must be thought of as animated hypotheses, much like laboratory experiments. In the model we control all aspects of behaviour, and the proper statement is: If the world works exactly as specified, the following things will happen. Because of the lack of validation, however, the degree of divergence between the real world and the model's output is largely unknown. Models will, therefore, be much more informative if they are used to evaluate highly divergent plans rather than minor details, and for relative comparisons rather than for absolute outputs. They can also be used to define extremes: If a desired output cannot be produced regardless of input, then likely the chances of producing that result are slim. In this way, models can serve as a neutral evaluation of a variety of design concepts.

To function primarily as a tool for hypothesis evaluation, the model dynamics must be understandable. If models become too complex, then they lose this property. Therefore the properties of simplicity and transparency are paramount. Often abstractions made for the sake of simplicity lead to a lack of transparency. In the worst case, these abstractions lead to complex models that are full of dubious assumptions. When modelling wildlife species we have found that individual organism simulators allow detailed models to be produced with few assumptions and few rules. These models generally require minimal spatial abstraction, allowing a high degree of transparency and realism in the spatial aspects. If the spatial components of a plan are critical, then individual organism simulators become very appealing.

An additional advantage of using the individual organism as the modelling unit is that most data are collected on individuals. There is little direct data to directly assess populations. Recent advances in multivariate statistics allow measured habitat quality to be evaluated based on the composition and spatial arrangement of habitat at multiple scales. Measured habitat quality can be partitioned into compositional and spatial elements at the scale of the point where habitat is measured, the patch in which the point exists, and the landscape in which the patch is embedded. A habitat model based on these partitioning methods allows for evaluation not only of a current landscape, but also of future landscapes that vary both in composition and spatial arrangement.

Regardless of how carefully a model is constructed, models are attackable. In a testable engineering model, it is possible to directly assess the influence of simplification and abstraction. With an untestable ecological model, these necessary properties will remain contentious. Models are, by nature, extremely honest; hypotheses must be stated explicitly. This honesty coupled with a lack of validation allows multiple points where model results can be questioned. In this context, it is doubly important that a model's behaviour be well understood and agreed upon by most of the interested parties, and that the results not be misinterpreted.

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A B.C. Perspective on Landscape and Population Modelling

MARVIN ENG*

Introduction

I was asked to give a B.C. perspective on landscape and population models. That task is rather difficult, particularly given that I only have 10 minutes. So, this will be my perspective with a bit of B.C. flavour. To give you a hint on my perspective I will start by saying that there are two kinds of people in the world: the kind of people that like to divide things into two different kinds and the kind of people that don't. Therefore, it should come as no surprise that I posit two kinds of models:

1. Models to aid in decision-making;
2. Models to enable improved understanding.

This distinction could roughly equals "management-oriented models" and "research-oriented models." This distinction is nothing new. Bunnell (1989) cited Caswell (1976) for the elegance of the distinction. The distinction is a crucial. These two kinds of models are built differently and give different kinds of results. Clearly, for this workshop, we need a model to aid in decision-making.

Landscape scale decisions about natural resource management have three characteristics that make them difficult:

1. *Complexity:* In this context complexity arises because the decision "space" combines large areas and long time frames, and includes several interacting processes;
2. *Uncertainty:* All I will say now about uncertainty is that we must explicitly incorporate it as a fundamental feature of our modelling approach. Therefore we are constrained in our choice of modelling tools. A lengthy discussion is not possible but if you are willing to accept another model dichotomy, between optimization and simulation models, then I will suggest that only simulation approaches are suitable in this context;
3. *Deadlines:* Some might argue that the only real difference between models to aid decision-making and models to improve understanding is that researchers are not constrained by deadlines. Whether or not this true, the fact remains that decision makers often have deadlines and any modelling process designed to aid them must adhere to those deadlines.

Collaboration

How can we create models that deal with complexity and uncertainty and do it within prescribed deadlines? I suggest that we look at examples where people are successfully dealing with this class of problem and find common denominators in their approaches. To continue with the B.C. flavour, two excellent examples are the Omineca Northern Caribou Project (*www.slocan.com/irm/projects/caribou/index.html*) and the North Coast LRMP Decision Support System (*srmwww.gov.bc.ca/ske/lrmp/ncoast/index.htm*). The overall approaches differ but the leaders of both projects could summarize the core of their approaches in a single word: "collaboration" (Scott McNay, Don Morgan, pers. comm.). Again, this is not new. Bunnell (1989) discussed at length the need for modelling teams. I don't have time for specifics about processes or software that facilitate collaborative model building. I will say that the heart of successful collaboration is involving the right people at the right time. Typically, you don't want decision makers programming computers and invariably you don't want computer programmers making decisions.

Collaboration only really deals with the deadlines. Many hands make light work. This leaves the issues of uncertainty and complexity.

Uncertainty

Uncertainty comes in three forms:

1. poor data;
2. incomplete understanding;
3. inherent uncertainty (stochastic nature).

A fundamental feature of uncertainty is that the further away we look, in space or time, the less certain we are. This suggests that uncertainty is linked to the issue of scale. In landscape ecology two parameters define scale: extent and grain. These parameters refer to both the temporal and spatial aspects of any modelling effort.

Extent refers to how large the problem is in both space and time. With respect to temporal extent, it seems intuitively clear that the further we look into the future, or the past, the less certain we are of the "result". An obvious choice of spatial extent, for this modelling exercise, might be the range of the Spotted Owl in British Columbia. Another choice is the entire range in North America. Note that this second choice does not necessarily result in a model that is more complex but it will undoubtedly result in projections that are less certain. It is important that the choice of extent of the model be a conscious one. It is possible that we can learn everything we need to know by modelling a few of the special resource management zones within the Spotted Owl Management Plan area. If that is the case it will significantly reduce the uncertainty of results.

Grain is approximately equal to resolution. It defines what the smallest unit of space or time will be in the model. There are good reasons to make the temporal grain of the model annual. Typically, spatial grain is the cell size of a grid. Again, the choice of spatial grain should clearly be a conscious one based on a variety of factors including the quality of the spatial data, the level of spatial detail with which the processes will be represented, and any computer memory constraints that may be imposed by a very fined grained representation.

Complexity

The central concept required for dealing with complexity is Occam's Razor*: "Entia non sunt multiplicanda praeter necessitatem.*" My favourite, though obviously not literal, translation is, "It is vain to do with more what can be done with fewer." A more pedestrian interpretation is "the simplest explanation is the best one." Initially, Occam's Razor seems trite. However, it does not, as many believe, admonish us to make simple models, it does require that we make the simplest possible models. Fundamentally, that is done by starting with no explanation and adding pieces one at a time, only if they are required to improve the explanation.

Occam's Razor is critical from a practical point of view. As Jabez Wilson said to Sherlock Holmes in *The Red Headed League* by Sir Arthur Conan-Doyle: "I thought at first you had done something clever, but I see there was nothing in it after all." The point is that we must be able to explain the results of our models. Only by employing parsimony can we hope to do that. The model output is the explicit consequences of the assumptions that were used to create it. At the end of the day, the modelling team must be able to take the model out of its explanation and describe the results in terms of the assumptions. Explanations like "that is an emergent property of the model" are not sufficient for a decision maker. This point is clearly expressed by Kerans (1994):

Experts, in our society, are called that precisely because they can arrive at well-informed and rational conclusions. If that is so, they should be able to explain, to a fair-minded but less well-informed observer, the reasons for their conclusions. If they cannot, they are not very expert. If something is worth knowing and relying upon, it is worth telling. Expertise commands deference only when the expert is coherent. Expertise loses a right to deference when it is not defensible.

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Ecological Uncertainty and the Conservation of Species

PETER ARCESE[*]

Uncertainty limits the reliability of model predictions. In the case of rare species, lack of data, a poor understanding of key ecological processes, and random effects related to small population size can render even "simple" models unreliable. Spotted Owls in British Columbia may offer a case in point, because, despite considerable work on the species in North America, a very small number of pairs are likely to be maintained in the available habitat in Canada. Because stochastic population processes are likely to account for a large fraction of variation in the future population size of owls, it is unlikely that we can build precise models of population trend. By contrast, models have predicted with some success the characteristics of suitable habitat for the species at stand and landscape scales. This suggests that the most efficient uses of models in British Columbia may be to identify efficient reserve designs that are likely to maintain Spotted Owls in the future. "Peripheral" species, with ranges just crossing into Canada, should be expected to exhibit extinct–recolonization dynamics over time. Habitat models might therefore take the long view that if owls are extirpated, habitat management would continue to facilitate natural recolonization.

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Applications, Assumptions, and Limitations of Landscape-Level Habitat and Population Models

BRUCE BLACKWELL*

Landscape-level disturbance has profound effects on ecosystems both at the spatial and temporal scale. Model examples will be used to demonstrate how forest fires can significantly alter our perception of sustainability on the landscape. Development of a simple risk profile, combining probability and consequence, can be used to simplify the complex temporal and spatial relationships associated with wildfire management, while enabling the development of appropriate fire management strategies. These same risk management principles could be considered in efforts to model Spotted Owl habitat. Previous modelling experience suggests that model outputs must be limited in complexity, transparent, understandable, and supportive of the decision-making process.

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Comments and Questions Concerning Landscape-Level Models

C: The complicated elements of the model should not be presented to the public. The information should be distilled and only the important parts presented. The right people should be involved at the right time, and they should be presented only with the information that is relevant to them.

C: It is important that the model synthesis be presented in a way that is understandable.

C: The stakeholder group can decide which components should be included. There should be a focus on being transparent and getting assessments at all phases.

C: It is insufficient for technical experts to produce something and give it away. The decision makers and stakeholders need to be involved from the beginning and through the process. Otherwise it will appear we've created something so complex that no one can understand it. The model should not be created behind closed doors.

C: If the uncertainties are dominant, we need to be transparent about this. It is important not to hide anything. With uncertainty, there is always a danger in how non-modellers will interpret the results. All we can do is present uncertainty and the potential for error. We have to let the managers decide what to do with it.

C: We should be careful about the way results are written up. Policy makers can take the conclusions to mean anything they want. There may be some unsavoury policy outcomes as a result of the modelling exercise.

C: Models need to incorporate everyone's ideas initially. Therefore they must be complicated to begin with. Eventually the model can be boiled down to a few dominant drivers. But if we don't know enough about the dominant drivers, we can't make management decisions. Risk frameworks should be made as simple as possible.

C: The model has three components that are quite simple: a projection model, a critical habitat component, and a population component. We need to include everyone here into the process so we can get the appropriate information to include in the model.

C: We need to be aware of the need to measure information from scientists with how we are going to manage (e.g., is it a random event we cannot control?).

C: The model should contain representations (accurate) of all parties involved.

C: If we lose the owls in this part of their range, do we need to address how to maintain the long-term habitat that could contribute to them coming back in the future?

Variable Density Thinning: A Technique to Aid in the Development of Spotted Owl Habitat in Managed Second-Growth Forests.

PAULA SWEDEEN AND ANDREW CAREY*

Research on habitat use by Spotted Owls and their prey in Washington and Oregon demonstrates that structurally and biologically complex forest provides optimal foraging conditions. Retrospective studies indicate that understorey plant development, coarse woody debris, multiple tree species, live and dead standing cavity trees, vertical connectivity within stands, and spatial heterogeneity caused by variable canopy cover within stands are associated with Spotted Owl prey populations. Silvicultural intervention in second-growth forests can influence forest development processes. Variable density thinning (alternating light and heavy thinning in a 2:1 ratio on a 0.2-ha scale), used with snag and cavity tree creation and underplanting with multiple tree species, can facilitate the recovery of multiple ecological processes that support balanced populations of arboreal and forest floor mammals. Experimental research has been conducted in western Washington on the effects of variable density thinning 5 years post-treatment. Abundance and diversity of plants, forest floor, and arboreal mammals increased in study plots, though there was a temporary reduction in flying squirrel abundance. Thus, the technique has promise in aiding Spotted Owl recovery in areas that are lacking in foraging and nesting habitat. Practical experience in implementing variable density thinning indicates that land managers benefit from learning about the ecological science that underlies the technique and from field training. In addition, foresters and loggers have much experience and knowledge to contribute to make variable density thinning operationally efficient, and thus affordable.

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Options for Enhancement, Restoration, and Maintenance of Spotted Owl Habitat

BRIAN D'ANJOU, ROBERTA PARISH, AND LOUISE WATERHOUSE*

The Coast Forest Region (Nanaimo) and Research Branch (Victoria), with industry and academia as partners, are preparing a review that summarizes reported information on stand-level habitat suitable for the owl, describes relevant ecosystems (including natural disturbance characteristics), and reviews current allowable harvesting practices. Silvicultural tools that may assist the enhancement, restoration, or maintenance of stand structure considered key to Spotted Owl habitat will be summarized.

Information from Coastal Region silvicultural systems trials (Boston Bar Partial Cutting Study, Roberts Creek Study Forest, MASS Project, Silvicultural Treatments for Ecosystem Management (STEMS–Sayward), and the Forest Project: Weyerhaeuser) will demonstrate early implications of some treatments. We lack sites, however, on which to assess the long-term implications of silvicultural practices proposed. To model the stand structures that will result from stand manipulation, we plan to use TASS (Tree and Stand Simulator). Outcomes from TASS simulations will assist decision makers on the risk of different treatments and cost of implementation. This approach is especially relevant when experiments that manipulate forests for measurable outcomes require many years before the goal may be assessed.

To model the multi-canopy and multi-aged stands likely to meet owl habitat requirements, we needed to update the branch and stem diameter growth model already in TASS. This will improve projections of crown structure and extend ability of TASS to model trees older than 150 years.

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Stand-Level Fire and Fuel Dynamics in the Coast–Interior Transition Zone

BOB GRAY*

Stand-level habitat attributes used by the Northern Spotted Owl are the product of both historic fire regimes and the interruption of those regimes. The area to the east of the Coast Mountain Range in British Columbia is known as the Coast–Interior Transition Zone (CITZ) owing to the ecological impacts of both maritime and continental climates. This area of the Squamish Forest District, and specifically the Birkenhead and Gates Landscape Units (BGLU), has been fairly extensively studied for historic fire regimes and fuel dynamics. The significant "rain shadow" effect on the lee side of the Coast Range—mean annual precipitation at Whistler is 1,229 mm while at Seton Lake it is only 329 mm—means that there are favourable seasonal conditions conducive to fire start and spread throughout this zone, especially as one travels from west to east.

Historic fire regime studies by biogeoclimatic zone have yielded the following mean fire intervals: IDFww, 5.9–17 years; CWHds1, 17–20 years; and ESSFmw, 21 years. The data from studies in the IDFww indicate both short-return interval fire regimes and frequent, mixed-severity fire regimes. The lone CWHds1 site is characterized by a frequent, mixed-severity fire regime although it is likely that a less frequent but mixed-severity regime is also present in this zone. The ESSFmw site indicates a fairly frequent, mixed-severity fire regime although this zone is also likely to contain a wide variety of regimes.

Historic fire regimes result in certain stand characteristics including species and structures. In the absence of fire these characteristics change. The more extensive the fire regime departure from its historic frequency, the greater the chance of a subsequent fire negatively affecting historical fire regime-dependent characteristics. This departure is known as the fire regime condition class, with no departure in frequency rated as one, while an extensive departure is rated as a three.

The BGLU contains five distinct forest types corresponding to their historic fire regime. The low elevation dry forests of ponderosa pine and Douglas-fir historically burned very frequently and under low intensity, resulting in open stands of large-diameter trees with a diverse and productive understorey. Stands today are dense, consist mostly of young, small-diameter Douglas-fir, and have shaded out most of the understorey. Mid-elevation dry forests of Douglas-fir and lodgepole pine historically contained a high proportion of Douglas-fir and a low proportion of pine. It is suggested that with a frequent, mixed-severity fire regime, lodgepole pine was kept in check by frequent fire. Individuals would survive a fire and seed burned areas only to be heavily thinned by a subsequent fire. Following the last fire in the late 1800s, these seedlings were not thinned. Starting in the early 1980s, the mountain pine beetle began to kill lodgepole pine throughout this forest type leading to today's fairly extensive fuel problem. High-elevation dry forests of mixed conifers, Engelmann spruce, subalpine fir, lodgepole pine, western white pine, whitebark pine, and Douglas-fir were suspected to be very open and dominated by fire-tolerant species, and productive shrub and herb communities. The interruption of fairly frequent fire has resulted in high stand stocking, the proliferation of non fire adapted species, and infestations of a number of insect pests.

Associated with the low- and mid-elevation dry forests are moist, productive areas referred to as "wildfire refugia." These small-scale, embedded areas burned less frequently than the dry matrix around them and thus supported significantly different stand characteristics including many fire-intolerant tree species, snags, and downed logs. These forest types were maintained on the landscape by the frequent fire regime around them. Large-scale fire refugia can be found in moist, north aspect landscapes in the CITZ where fires were very infrequent and resulting stand structure was complex. These areas also owe their existence to the frequency of fire in adjacent dry forest types.

The interruption of historic fires on dry aspects in the CITZ has significantly increased stand density, increased density of fire-intolerant trees, increased incidence of insects and diseases, increased fuel loading, and decreased species diversity. All three dry forest types are considered to be in condition class three meaning that a wildfire in their current condition will likely result in the loss of most if not all significant ecosystem attributes. Both moist forest types are still in condition class 1, but owing to the condition of adjacent dry forest types will likely be negatively impacted by a wildfire burning in the dry forests.

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Biography: R.W. Gray Consulting Ltd. specializes in researching the past occurrence of fire and its effects on ecosystem structure and composition, and the operational use of prescription-guided burning for a number of objectives including hazard reduction, silviculture site preparation, and ecosystem restoration. Robert W. Gray, the company president, is a fire ecologist who received his academic training at the University of Montana, and practical training in fire regime research and prescribed fire working for federal agencies, tribal government, and private industry in Montana, Idaho, Washington, Arizona, and British Columbia. The company was established in British Columbia in 1996 and has since conducted historical fire regime studies throughout the southern interior of B.C. Beginning in 1999, R.W. Gray Consulting, Ltd. has worked closely with the Squamish Forest District in the development of an integrated prescribed fire program for Small Business operations in the Coast–Interior Transition Zone.

Population Ecology of Northern Flying Squirrels (*Glaucomys sabrinus*)

DOUG RANSOME*

Introduction

The presentation reviewed the biology of northern flying squirrels. Four studies in British Columbia have recently examined their ecology and the influence of forest management on their population dynamics. The key findings from these studies were summarized. The four studies were:[1]

1. Ransome, D.B. and T.P. Sullivan. 2003. Population dynamics of *Glaucomys sabrinus* and *Tamiasciurus douglasii* in old-growth and second-growth stands of coastal coniferous forests. Canadian Journal of Forest Research 33:587–596.
2. Ransome, D.B. and T.P. Sullivan. 2004. Effects of food and den-site supplementation on populations of *Glaucomys sabrinus* and *Tamiasciurus douglasii*. Journal of Mammalogy, April 2004. In press.

[1] Note that full references for all literature cited in this abstract are available in the four articles cited.

3. Anderson, J. 2003. The relationship between the production of hypogeous sporocarps and the density and diet of northern flying squirrels in western hemlock forests of coastal B.C. M.Sc. thesis. University of British Columbia, Department of Forest Science, Vancouver, B.C.
4. Ransome, D.B., P.M.F. Lindgren, D.S. Sullivan, and T.P. Sullivan. 2004. Long-term responses of ecosystem components to stand thinning in young lodgepole pine forests II: population dynamics of red squirrels and northern flying squirrels. Submitted.

Why Are Flying Squirrels Important to Spotted Owls?

Northern flying squirrels are the primary prey item of Northern Spotted Owls (Dunbar and Blackburn 1994; Carey et al. 1992; Forsman et al. 1977, 1984, 1991). Recent studies have found a positive relationship between prey abundance and the reproductive success of Northern Spotted Owls (White 1996; Thome et al. 1999), their home range size and habitat use (Carey et al. 1992; Zabel et al. 1995; Ward et al. 1998), and their survival during natal dispersal (Miller et al. 1997). Understanding the ecology of the owl's prey is important in developing effective management plans (Carey et al. 1992).

Biology of Northern Flying Squirrels

Northern flying squirrels are a small arboreal sciurid found in forested regions over most of North America. They are typically found in habitats dominated by conifers or a mixed coniferous-deciduous overstorey. They primarily consume hypogeous fungi during snow-free periods and lichens during winter. They inhabit two types of nests: those inside tree cavities and those constructed in the canopy of conifers or witches' broom. The uncertainties regarding the ecology of northern flying squirrels include:

- Their habitat preference: Are they more abundant in old-growth than second-growth stands?
- Limiting factors: What resources limit the abundance of northern flying squirrels?
- Response to forest management: How do northern flying squirrel populations respond to forest management?

Habitat Preference (Ransome and Sullivan 2003)

Studies examining density of northern flying squirrels in old-growth and second-growth stands have produced variable results. In some studies northern flying squirrels were more abundant in old-growth than second-growth stands (7 studies). Other studies found no difference in abundance of northern flying squirrels between old-growth and second-growth stands (6 studies). Most studies examined populations of flying squirrels for 2 years or less, during the fall and occasionally during the spring, and based their conclusions on density alone, which may not necessarily reflect habitat quality.

We examined habitat preferences and population dynamics of northern flying squirrels in old-growth and mature second-growth stands in British Columbia. Populations were monitored in two old-growth and two mature second-growth stands from August 1995 to May 1999 every 5–6 weeks. We compared movement, population size, recruitment, mass of males, survival, and percentage of the population breeding between stand types. We were unable to detect major differences in all parameters examined between stand types. In addition, a review of the literature has shown that abundance of northern flying squirrels is variable. Their abundance can vary two- to threefold within similar stand types within the same study. Similarly, their abundance can vary among stand types in the same study; thus in some years old-growth stands may maintain a higher abundance of flying squirrels than second-growth stands, while the opposite is true in other years. We concluded that old-growth stands did not provide higher-quality habitat than second-growth stands for northern flying squirrels.

Limiting Factors (Ransome and Sullivan 2004)

Several studies have suggested that cavities may be the primary limiting factor for northern flying squirrels (Carey 1991, 1995; Carey et al. 1992, 1997). Other studies have indicated that food abundance was the primary limiting factor (Waters and Zabel 1995; North et al. 1997; Ransome and Sullivan 1997).

We examined the effects of food and den site supplementation on population dynamics of northern flying squirrels in coastal second-growth stands in British Columbia. We tested the hypothesis that populations of northern flying squirrels were primarily limited by abundance of food, not den sites. The study included four treatments: food supplementation, food and nest box supplementation, nest box supplementation, and control. There were no differences in all parameters examined, except survival, among treatments for northern flying squirrels. Survival decreased significantly from pre- to post-treatment periods in stands without food supplementation. During this period, survival increased significantly or remained unchanged in stands with food supplementation. In addition, occupancy rate of nest boxes in stands supplemented with nest boxes and food was significantly higher (1998 – 88.4%, 1999 – 75.0%) than in stands with nest boxes only (1998 – 7.0%, 1999 – 12.2%). We concluded that northern flying squirrels readily used nest boxes but their populations were not limited by availability of den sites. Availability of food limited populations of flying squirrels and was more critical than availability of den sites. These results support the conclusion of a previous study that reported a twofold increase in density of northern flying squirrels in response to large-scale food supplementation (Ransome and Sullivan 1997; Journal of Mammalogy 78:538–549).

The diet of northern flying squirrels was examined in five mature second-growth stands of coastal coniferous forests in British Columbia (Anderson 2003). This study reported that plants were a major year-round component of the diet of northern flying squirrels. There appeared to be a positive relationship between the abundance of northern flying squirrels and production of truffles on four of the five sites examined.

Response to Forest Management (Ransome et al. 2004)

The response of northern flying squirrels to stand manipulations is poorly understood. This study was designed to test the hypothesis that population dynamics (abundance, reproduction, and survival) of northern flying squirrels would be enhanced to levels recorded in old-growth forests by large-scale pre-commercial thinning of young lodgepole pine forests. The study was conducted in three locations in British Columbia: Prince George, Kamloops, and Penticton. Each study area had five treatments: old-growth stand, unthinned stand, and stands spaced to 500, 1,000, and 2,000 stems/ha. Our preliminary results indicate that the abundance of northern flying squirrels could be enhanced by large-scale pre-commercial thinning of young lodgepole pine forests. Abundance of flying squirrels in high-density stands (2,000 stems/ha) may exceed levels recorded in old-growth lodgepole pine forests.

Summary

The four studies summarized above addressed three key uncertainties regarding the ecology of northern flying squirrels:

- Their habitat preference: Are they more abundant in old-growth than second-growth stands? Second-growth stands maintain healthy populations of northern flying squirrels; often similar to that found in old-growth stands;
- Limiting factors: What resources limit the abundance of northern flying squirrels? Food abundance was more important in limiting flying squirrels than abundance of den sites. Plant material was a major food item for northern flying squirrels;

- Response to forest management: How do northern flying squirrel populations respond to forest management? Carrying capacity of northern flying squirrels in lodgepole pine stands may be enhanced through forest management, beyond that supported by old-growth stands.

Understanding the ecology of the owl's prey is important in developing effective management plans (Carey et al. 1992). The above studies have enhanced our current knowledge regarding the ecology of northern flying squirrels, the primary prey species of Northern Spotted Owls. This information, in turn, may be used to enhance foraging habitat for the Northern Spotted Owl.

AUTHOR

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Biography: Douglas B. Ransome is a research scientist with DBR Forestry-Wildlife Integrated Management and a research associate of the Applied Mammal Research Institute. He obtained his M.Sc. in 1994, and completed his Ph.D. on northern flying squirrels and Douglas squirrels in 2001, both from UBC. His research interests include examining the effects of forest practices on various wildlife populations, particularly arboreal mammals.

Comments and Questions Concerning Stand-Level Models

C: Abundance versus availability of prey (flying squirrels)–you cannot quantify prey availability but must assume that increased abundance equals increased availability.

MODERATOR'S SUMMARY FOR SESSION 2

Understanding Models, their Uses, and Limitations

JOHN INNES*

Uses and limitations of models:

- Models will not give precise, reliable output (answers). They are useful only for helping understand how processes work and for providing demonstrations of what might happen under certain conditions and assumptions;
- The Timber Supply Analysis, which forms the basis for many habitat predictions in the province, is a static forest that is assumed to be only influenced by humans. It does not handle the spatial distribution within timber supply areas well. Nor does it deal well with the natural agents that change forests;
- Models need to be empirical to be believable. Too many models have become too detached from reality. Modellers need to beware of hidden assumptions and unforeseen and random factors; they also need to be aware of the poor quality of their base information, such as the forest cover inventory;

- The output from models needs to be usable, such as a habitat quality index;
- Indices of connectivity, as generated by programs such as FRAGSTATS, are generally of little value. They do not provide an indication of the problems faced by organisms moving across the landscape. Similar conclusions have been reached in other studies in British Columbia (e.g., at Adams Lake);
- The public needs to be convinced that the model is useful. The more complex it is, the more difficult it will be to convince a skeptical public that it has a value;
- The processes incorporated into the model need to be understood if its value is to be realized;
- There is an unfortunate tendency for models to be used by managers *after* all the decisions have been made. Managers need to be educated in the use of models as a decision aid.

Types of questions that can be addressed by the model under development:

- How likely is a recovery in the B.C. population of Spotted Owls?
- If recovery is not possible within a reasonable time frame, can the B.C. population contribute to the regional sustainability of the population (throughout its range)?
- What other conservation options are feasible (such as population enhancement)?
- How can management of Spotted Owl habitat be better incorporated into forest management? Habitat supply can be linked into the Timber Supply Review process;
- The landscape dynamics model could be useful at looking at change;
- The model could help generate spatially explicit population models, including links between survivorship and habitat, and dispersal;
- The model will help test major design ideas, relative comparisons, and extremes. Essentially, it will enable animated hypotheses;
- The model is better designed to aid the evaluation, design, and restoration of habitat reserves. It is not useful for modelling populations when the numbers of individuals in those populations are very low;
- The model should help understand the importance of fire, including its frequency and impacts, and its spatial distribution;
- It will be useful for assessing stand development, as long as it is calibrated with real information.

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SESSION 3

Refining Critical Questions for the Model

BREAK-OUT GROUP MEETINGS: REFINEMENT OF QUESTIONS TO BE ADDRESSED BY MODEL

The modelling team faces several unanswered questions on how to incorporate variables that influence the Northern Spotted Owl and their habitat. The break-out group working sessions were conducted to address a pre-defined set of questions developed by the modelling team on three topic areas:

1. Habitat management;
2. Population ecology; and
3. Habitat enhancement.

Each of the three question sets were distributed with the workshop registration package so that participants were able to review the question sets and sign up for the groups based on their knowledge or skills. Following are the question sets, group participants, discussion notes, summary, and full forum discussion notes that followed each group presentation.

Group A: Habitat Management

Pre-defined Questions

Handout

Habitat Management Break-out Group

1. How is suitable habitat defined?

- Ecosystem type, age class, elevation, etc.

2. How important is it to define and model climatically transitional habitat types (e.g., CWH to IDF transition)?

- What stand-level characteristics define transitional habitat types? (e.g., species composition/ stand structure; age class; elevation; slope; stream density)
- How well do we understand the ecosystem processes and natural disturbance regimes in transitional habitat types? Can we model them with available data?
- How well does our management of these ecosystems reflect current ecological understanding?
- Do we need to distinguish nesting habitat between 250 years (wetter sites) and 200 years (drier)?
- Can we model the probability of transitional sites moving from one type to another?

3. What are the key attributes of Spotted Owl habitat at different scales?

(a) Landscape-level habitat:

- Amount/size of territory
- Percent suitable habitat
- Shape, contiguity, distribution
- Should territories be clustered?
- What are optimal numbers of clustered territories, and why?

(b) Nesting habitat:

- Amount/size of nest site
- Should we model different radius buffers to evaluate nest sites?
- Percent suitable habitat
- Shape, contiguity, distribution
- Other features?

(c) Foraging habitat:

- Definition of suitable habitat for foraging?
- Amount/size of foraging area? Does this vary seasonally?
- Other features (e.g., talus slopes)
- Contiguity of patches (or, effect of non-continuous patches)

(d) Dispersal habitat:

- Percent suitable habitat
- Effects of patch size
- Elevation, riparian, other?
- Barriers to dispersal (natural and man-made)? How do barriers operate—energy costs, mortality costs, other costs?

4. Can we capture the key habitat attributes identified above with the data we have?

5. What habitat characteristics may be contributing to population decline?

- Amount
- Distribution
- Edge effects
- Skewed age class
- Natural and man-made barriers?

6. Are amount, suitability, and distribution of habitat related to population decline (i.e., is loss of historic habitat indicative of population decline)?

7. How are the habitat requirements different on the limit of the Spotted Owl's range from the centre of the range, and what implication does this have for population numbers and success?

8. Should the potential effects of climate change on habitat be considered, and how should this be modelled?

Suggested Indicators

General landscape indicators

- Hectares of habitat by type (nesting, foraging, dispersal, and total)
- Hectares of habitat stratified by elevation/ecosystem/age class
- Hectares of suitable habitat within territories
- Mean patch size
- Connectivity (distance between LTACs; distance between patches of habitat of a given type (nesting, foraging, dispersal)
- Ratio of edge/interior forest condition (defined by forest age)

Economic indicators

- Cubic metres of timber/ha/management unit /licensee
- Standing timber inventory/time
- Jobs/time

Group Participants

John Innes (facilitator)
Jennifer Turner (note-taker)
Andrew Fall (modeller)
Kathryn Lindsay
Liz Williams
Jeff Stone
Myke Chutter
David Cunnington
Rick Kooistra
Andre Germain
Dave Marquis
Dan Barron
Don Heppner
John Stamp
Wayne Wall
Gene MacInnes
Marvin Eng
John Surgenor
Nancy South
Jared Hobbs
Warren Mitchell
Louise Waterhouse

Group Discussion Notes

Objectives of this session are to review the pre-defined list of questions, prioritize which questions are the most important, clearly identify habitat management knowledge availability and gaps, and provide advice to the Spotted Owl Recovery Team on how to move forward with the modelling process as it relates to habitat management.

Question 1 How is suitable habitat defined?

- It is defined by all of the forest cover attributes (BEC unit, age class, crown closure, stand height, elevation, etc.)? We have this information and it is based on research in the United States and Canada. There was a recommendation to use B.C. data when available.
- The definition of suitable habitat includes *potentially* (capability?) suitable habitat—it does not account for quality of habitat, which requires consideration of patch size and connectivity (i.e., distribution of habitat). If you have X amount of suitable habitat, that amount should correlate to a certain population size, but this is not the case. The definition may need to include distribution parameters.
- The current definition in the model comes from a stand-level suitability index. The spatial component addresses how much is needed, but the amount is not the only criterion as distribution and connectivity are critical. Recovery planning should address amount and distribution of habitat.
- There will always be the potential to improve the data on which we base models (e.g., forest cover data). What we have for a current definition of habitat is that it is a function of BEC zone, age class, crown closure, height class, and elevation. Is this adequate?
- What about species composition? Is this covered by BEC zone? [There was some disagreement as to whether species composition is tied to BEC zone.]
- The best criteria are forest cover attributes (see above) including age class and height class. Site index may be useful but is not available everywhere. We are not currently using air photos to identify suitable habitat. Age, tree height, and site index may be sufficient to recognize where suitable habitats are, based on the data we have. Using air photos comes later.

Question 2 How important is it to define and model climatically transitional habitat types (e.g., CWH to IDF transition)?

- Discussion revealed that this was not a critically important issue as transitional habitat types are limited and the use of BEC zones will meet modelling needs.

Question 3 What are the key attributes of Spotted Owl habitat at different scales?

(a) Landscape-level habitat

- Suitable habitat/habitat quality is related to patch size. The Spotted Owl will respond to fragmentation by expanding its home range. Research has shown that they use about 70% of a 3,200-ha area. If this is fragmented, they will expand their home range. The amount of old forest that is being used in a year will not change, but the Spotted Owl territory expands to include the same amount of old forest (Types A and B) up to about 7,000 ha, at which point the birds move away or die. That is the maximum area that, if exceeded, will compromise survival of Spotted Owls. We should be looking at a balance between the amount of old forest maintained in a certain area and the size of that area, up to 7,000 ha. We need to be intelligent on how we cluster our reserves. We need to consider the level of harvest within an area as well. The approximately 2,200 ha (70% of 3,200 ha) of currently suitable habitat within the managed home range does not need to be contiguous, but there needs to be some connectivity (movement expense activity).

As the landscape becomes fragmented, we need to think about its effect on predators. The birds will not be lost instantly as there will be a threshold for effects. Light volume removal and heavy volume removal might be an option for meeting both economic and owl values.

- While 7,000 ha is the maximum territory size, this requires more land to be managed. It is better to manage owls in 3,200 ha that contain at least 2,200 ha (70%) of old forest, in age class 7–9. [Editor's note: 44 of 101 LTACs had less than this amount of habitat when first designated.]
- What does a pair of owls actually need? A cluster of home ranges is only as good as its connectivity to another cluster of home ranges. We need a two-step management process where we identify habitats and the reserve design, then look at connectivity requirements between them, and the retention that needs to be maintained between these. Connectivity directly says how good our clusters are in growing the population. Using habitat resistance for a particular species across a landscape is a good technique. We need to put in different scales for barriers, as some gap types represent more of a barrier than others. If the barrier is likely to impede owl movement, then action is required.
- If you have 5 clusters of populations of 25 pairs of owls, you are looking at a metapopulation that is not as likely to wink out, and connectivity is not as critical. If you have 50 clusters of 2 pairs, there is a much greater need for connectivity.
- Are we capable of creating a metapopulation if it doesn't currently exist? If it is a dispersed population, we have to accept this; it is likely grouped out of convenience. This changes the importance of dispersal habitat. We need a more technical workshop to deal with this connectivity issue.
- We should look at the landscape and use it to model different management scenarios, and then bring in population and ecology data. We need optimization of reserve design. We may need to shift the location of LTACs to optimize reserve placement.

(b) Nesting habitat

- There is a need to focus on conservation of nesting habitat;
- Type A? Suitable habitat (minimum age 140 years) needs to be refined to recognize, within that type, what is actually nesting habitat. In particular, stand age needs to be better defined;
- We are doing some modelling to identify fire refugia. Slope and aspect can be analyzed to identify nesting patches.
- Model refinement is required to recognize Type C nesting habitat, using stand age surrogates of a minimum of 250 years old on the coast and 200 years in the interior.
- We cannot identify Type C nesting habitat with current forest cover maps, but should be able to model Type C nesting habitat using stand age as a surrogate.
- We need to make sure we identify nesting habitat and foraging potential, and then look at how areas should be clustered (e.g., 20 LTACs/reserve [SRMZ]).
- Light volume removal will compromise nesting habitat. We need to recognize nesting habitat and avoid these areas or limit impacts. There may be the potential to overlap some nesting habitat with Old Growth Management Areas (OGMAs) and ungulate winter ranges (UWRs), although there are some policy constraints to this as well.

(c) Foraging habitat

- The model should include at least two suitable habitats types (A and B), and then examine these types for viable owl territories.
- Foraging habitat can be recruited, which also serves as dispersal habitat, but we need to recognize and conserve nesting habitat independently.
- A particular hectare of foraging habitat is not equal across the board. Owls need at least 2,200 ha

of suitable foraging habitat within their home range, with an average of 418.3 ha of old growth for nesting. This habitat should be connected, but it does not necessarily need to be contiguous. Owls will cross open spaces, but their risk of mortality increases with the size of the gap.

- We need to ensure there is enough foraging habitat between reserves so that they can make it from one to the next. U.S. studies show that 20% retention is a threshold below which obstacles to Spotted Owl survival become insurmountable.
- It is important we make sure that attributes of suitable habitat are correct. Age classes may have caused a problem and this may need to be addressed. A 140-year minimum is used for Spotted Owl habitat, but a 100-year minimum was brought in to reduce the impact on timber harvesting. In the United States, 200 years is the minimum.

(d) Dispersal habitat

- Dispersal habitat is essentially no different from foraging habitat. The only difference is that dispersal habitat is not occupied by owls year round. What level do we have to maintain to ensure dispersal occurs between clusters? Again, U.S. studies show that 20% retention is a threshold below which obstacles to Spotted Owl survival become insurmountable.
- The degree of isolation of remnant stands in habitat managed only for dispersal is critical.
- Interpretation of suitable habitat is a key issue. One hectare fragments are not suitable, so we need to consider minimum patch size. We can say it's suitable in terms of stand requirements, but then we must ask if it is good enough quality. This is where patch size, connectivity, proximity, etc., fit in.

Question 4 Can we capture the key habitat attributes identified above with the data we have?

- We need to recognize that we are relying on U.S. data to determine habitat management thresholds. Are we comfortable with this? We need to rely on U.S. data to some degree, but we should be careful about assumptions in how similar the areas are. If we have good B.C. data, we should use it. We should use U.S. data when we need to, but cautiously. We are on our first pass; they are on their third pass. We have coarse woody debris artifacts that are not present in many managed U.S. forests. We should look at habitat supply over time and relate it to changes in the spatial distribution of LTACs and how that relates to connectivity.
- We define habitat using the available information that was collected for other purposes (e.g., timber supply). We are not going to look at this here today but in the future we will need to define habitat in terms of owl suitability. Note that we are using timber-based inventory to define owl habitat and those variables may not be appropriate. For example, basal area could be translated into bole surface area.
- We have to use what information is available. We know that this is inexact, but those are the cards that we have been dealt and we need to accept this. But we also need to project to determine future information needs.
- We should be cautious about saying forest inventories are "better." They are at a very strategic level and it is unclear that they are better than the old forest cover information. Forest inventories do not exist for the entire range. It is better to accept forest cover data with flaws because this information is consistent across the Spotted Owl range.
- There is not that much difference between vegetation resource inventory and forest cover data in terms of attributes. It is the resolution that is different. They have the same timber information and the same attributes.
- The seamless database is 10 years out of date. We need to bring the depletion layer up to date. It appears to have been updated for Squamish, based on old forest cover. We need to decide what

the degree of inaccuracy is, in the forest cover data, and whether it is going to affect our results when we are coarse planning.

- The Lillooet area data were not included in the original seamless database, so we have the problem of bringing them into the database.
- Because the models are not yet developed, what questions can we model within the different levels of data that we have available to us? Ideally the whole model range, but given that the Fraser TSA is the most updated, there may be some questions within the model we could address just using Fraser TSA data.
- The seamless data for Squamish and Chilliwack need to be updated. Lillooet TSA data have been updated to 2002–it has a comparable data set for forest cover.
- What about TEM information? Is it used in the model? It is important to get as much and as good information as possible. Ideally we should have it for the whole area, but if it is available for only a portion of the area, it could be used to do some verification or comparison work. Extra data are always useful, but we must go forward with the data we have and include other information as it becomes available.
- Locations for where we have seamless data are "all over the map." There were some concerns about this, and has got us into trouble before. That is why the model has two scales; to be able to ask as much as we can with better quality data, but some questions are inherently at that big scale.
- Can we identify a strategy that will make sure the best available data are used? Glenn, Liz, Wayne, and Louise are tracking down data. An important question when we think about owl habitat is: What data can we accept? Louise will be contacting people. We have the modelling going on right now for the recovery team using existing information because some decisions have to be made about upgrading the model. We cannot use data constraints to stop modelling because of the tight time frames from research and development.

Question 5 What habitat characteristics may be contributing to population decline?

Question was not discussed.

Question 6 Are amount, suitability, and distribution of habitat related to population decline (i.e., is loss of historic habitat indicative of population decline)?

Question was not discussed.

Question 7 How are the habitat requirements different on the limit of the Spotted Owl's range from the centre of the range, and what implication does this have for population numbers and success?

Question was not discussed.

Question 8 Should the potential effects of climate change on habitat be considered, and how should this be modelled?

Question was not discussed.

Parking Lot (issues noted but not discussed due to time limitations)

- The name of this break-out session should have been habitat requirements, not habitat management. We need to be able to define habitat in management terms as well, and that should be a discussion point that flows into this afternoon. For example, percent suitable habitat becomes a management decision: What do we mean by percent suitable?

- We are not in agreement on elevation. We may be a little too generous in what we accept. The elevation maximum should be lower on the coast than in the interior. We need to refine the elevation cap (1,300 m is too high) and bring in Type C for nesting.
- Why is the east side of the Merritt Forest District not included? It will be included in the model. The Merritt Forest District didn't look as good when it was ground-truthed, due to height of land barrier and south and north–south barriers. There have not been adequate assessments in certain areas; this is one shortfall of the survey. Alpine habitats and water bodies are not necessarily barriers, so Spotted Owls could be in the Merritt Forest District. Given that we do not know about owls on the east side, we can apply what definition we do have for identified areas that might be suitable to help guide efforts.
- It is a good model, but the model cannot pick up some things (e.g., snow depth or persistence) even if the forest structure meets all the requirements within the model. The model can be used to find owls; we just need to interpret the results a little bit. There needs to be a Type C to reflect nesting habitat.
- There is a temporal element to suitable habitat as well. A small patch not good today may be critical 100 years from now.
- Finer scale questions can be included for the Fraser Timber Supply Area (TSA), but there are also objectives to be addressed at the whole landscape. Can we extrapolate to these areas? Pulling together the data can be huge task. We have forest cover data for the whole area but at a much coarser quality. Even if we had all the data for owl range, there is no VRI data for the whole range. The habitat model captures the biology: certain attributes can only be captured for the Fraser, while other attributes can be captured for the whole area. Can we live without certain pieces?
- How are we going to update the other two forest districts so that we can ask the same questions as in the Fraser TSA? That can happen simultaneously – ask the broad questions for areas other than the Fraser TSA first, but we need a strategy for getting at the finer details in the other TSAs.
- Other TSAs have already done some work with LANDSAT data, but only depletions can be identified with that.
- The information from the model is going to be wrong and we need to take steps to verify the results it provides. This can be done through air photo interpretation.
- You can look at the results the model gives you. Few fine resolution decisions can be made with this model. The error should get averaged out. We must accept this, get past it, and move forward.
- The value of the model is that we can look at relative differences. Hopefully with the range in thinking for the management of Spotted Owl habitat, we will pick up those differences.

Summary

This break-out session had a wide-ranging discussion of the issues surrounding habitat management. From the perspective of habitat management, the most worrying issue was the lack of updated forest cover data. Also, a potential concern is the lack of B.C. demographic data. This limitation is surprising for a species on the brink of extirpation in Canada, although there is a consensus that we can rely on U.S. data where applicable. Also, there is some potential for identifying additional owl sites in British Columbia, based on the presence of a few large areas of suitable habitat that have been under-represented in surveys. There are recognized limitations associated with the forest inventory database, a problem that is not unique to the Spotted Owl case. This creates a need to interpret habitat suitability modelling cautiously in some areas. There has been a failure to incorporate habitat features important to Spotted Owls into forest inventories done within its range, and even the current database has inadequacies because for some areas, habitat depletions have not been incorporated. Forest inventories in other countries (such as Switzerland) are much more efficient at collecting information that is relevant to the multiple values of forests; in British Columbia, the focus continues to be on timber supply. Improving the existing inventory, and at least ensuring that it is up-to-date, should be a major priority.

There appears to be some flexibility in Spotted Owl habitat requirements for foraging and dispersal, although throughout all habitat classifications they benefit from heterogeneous forest structure. However, Spotted Owls have very strict nesting habitat requirements. In some cases, depending on ecosystem type, nesting habitat may be related to fire refugia within old-growth areas: on the coast these refugia may have trees more than 250 years old, and in the interior the tree age may be more than 200 years old. These stands need to be linked to an overall territory of 3,200 ha of mature and old forest. This does not need to be a contiguous block, but as much connectivity as possible should be maintained.

The existing habitat supply model has limitations. In particular, it needs to better recognize actual nesting habitats, and it needs to better take into account the spatial pattern of forest within the landscape. This was clear from the maps of nesting habitat: isolated fragments of suitable habitat were shown with the City of West Vancouver, yet these are clearly too small to support a breeding pair of Spotted Owls. Isolated patches such as these need to be removed from the map and from the calculations of potential breeding habitat.

Full Forum Discussion

Question 1 Are habitat characteristics different between wet and dry ecosystems?

1. Recognition of nesting habitat: 200 years, interior; 250 years, coastal. Forest succession in the two different ecosystems differs; it may need to account for this in the model.

Question 2 What are the key characteristics of fire refugia?

1. Stand age is all we have as a surrogate (can also use aspect and slope, etc.).
2. Need to further define nesting stands; the use of air photos may be applicable.

Question 3 Would the model use VRI in Fraser TSA and forest cover in other areas?

1. Yes.
2. Some concern in using the Fraser TSA and extrapolating to other areas as conditions don't necessarily reflect other areas.
3. Need to get forest attributes from different information sources.
4. Stitching data sets together will be challenging!
5. TSR 3 (Lillooet) is starting—it will help.
6. There are some opportunities to get more up-to-date information.
7. Why are data inventories a limitation if this is such a priority?

Group B: Population Ecology

Pre-defined Questions

Handout

Population Ecology Break-out Group

1. How do we define the population?

- Is there a metapopulation in British Columbia (i.e., a population of populations) or simply a widely dispersed population? Are there isolated subpopulations?
- Do the existing trend analyses help define the metapopulation structure for Spotted Owls in British Columbia?
- Should this species be modelled as subpopulations, or as a single population?
- Is there value at looking at a subpopulation in the Fraser TSA, where more detailed habitat information and a recent timber supply analysis is presently available?
- Is the B.C. population isolated, connected, or partially connected to the U.S. population?
- Does what happens in the United States "matter" to British Columbia?
- What is the trend in the level of isolation in B.C. Spotted Owl population/subpopulations? What are the likely barriers to increasing the connectivity of the population?
- What are the assumptions associated with sustaining a metapopulation?
- What are the assumptions associated with sustaining three subpopulations?
- How certain are we about assuming either a single metapopulation or three subpopulations, and what are the risks associated with each assumption?
- Should Spotted Owls be managed as subpopulations?

2. What factors influence the population?

- What are the most important factors influencing population size and trend (e.g., habitat, predation, competition, disease)?
- Given these factors, how can we adequately capture them in the model? Do we have the data to do so?
- Considering these factors, what do we need to do to get the population up to (a) stable numbers (a long-term viable population)? and (b) recovery goal numbers (125 pairs)?
- What actions are likely to achieve these goals? What probability of success does each have?
- Should we define some probability thresholds as criteria for success for certain actions?

3. What is a sustainable population? What, where, and when?

- Is it reasonable to sustain this population (metapopulation/subpopulation) throughout its range (the COSEWIC rule)? Should we concentrate on a portion of the range (e.g., drier ecosystems; currently most productive)?
- What is the probability of sustaining the population across its full range?
- Is it necessary to have a core population?
- What is an acceptable time frame for population stabilization and recovery?
- What data do we have to model population dynamics, and how applicable is the U.S. data to British Columbia?
- How much uncertainty do we have in the factors discussed above, and how do we best incorporate uncertainty about the population into the model?

4. How important are social cues to behaviour?

- How important are social cues in determining breeding success, dispersal, and/or mortality in Spotted Owls?
- How do Barred Owls influence Spotted Owl behaviour/movement?
- What is the likelihood of Barred Owl hybridizing with Spotted Owl? What are its primary effects on population dynamics? How important to achieving the recovery goals is it to model this likelihood?
- To what degree are social cues from either Spotted Owl or Barred Owl resulting in use of suboptimal habitat?
- Should this be considered in design of a translocation strategy?
- How can the effects of social cues be modelled?

5. What do we know about mortality and survivorship related to dispersal?

- Juvenile dispersal
- Breeding dispersal
- "Divorce" dispersal
- Competition-mediated dispersal

6. How important is it to include West Nile Virus as a factor in the model?

- Do we have enough information on WNV to make any assumptions (positive or negative)?

7. Should the model include population augmentation scenarios? If so, how would the population increase through:

- Over-wintering juveniles
- Food augmentation
- Translocation
- How certain are we of these assumptions?

Suggested Indicators:

Primary: Population trend (lambda or % change/yr); total population size/time; ratio of adults to juveniles; total mortality by life stage.

Derived: Probability of a stable population within certain time frame (e.g., 3 generations; 100 years, etc.); probability of reaching recovery population goal within certain time frame; probability of quasi-extinction within a time frame.

Group Participants

Shawn Morford (co-facilitator)
Kathi Zimmerman (co-facilitator)
Dan O'Brien (modeller)
Mary Rothfels
Les Kiss
Dale Herter
Joe Buchanan
Bruce Morgan
Keith Simpson
Carl Schwartz
Jamie Smith
Derek Bonin
Peter Arcese
Trish Hayes

Group Discussion Notes

Objectives of this session are to review a predefined list of questions, prioritize which questions are the most important, clearly identify population ecology knowledge availability and gaps, and provide advice to the Spotted Owl Recovery Team on how to move forward with the modelling process as it relates to population ecology.

Question 1 How do we define the population?

- Defining the extent of the population is a high priority, as this will have a large influence on the decision-making process and how we manage the populations.
- Group decided that the owls in British Columbia should be considered a distinct population, which is then subdivided into wet (coastal cedar–hemlock) versus dry (Douglas-fir associated) subpopulations or ecotypes.
- Determining whether the small B.C. population size can ever be a viable self-sustaining population is a high priority.
- Is there north to south movements between British Columbia and Washington? Nominal exchange, but doesn't require much to ensure gene flow.
- If British Columbia can't achieve Spotted Owl recovery and requires input from Washington, we need to ensure connectivity between the two is available; opportunities for north–south movements are narrow.
- One model scenario could be to assume British Columbia is a closed population to see if the population will persist, then run a second scenario assuming exchange occurs.
- Important to define which populations and what population size to use as an input into the model.
- Is there a U.S. model that we can input B.C. data? Not to our knowledge.
- Can we compare our info to what is available in the United States (i.e., bring U.S. data into the B.C. model)? Yes, U.S. data currently represent best available knowledge.
- Is there too much emphasis on the population component of the model? How instrumental is the population component? Should determine how much emphasis needs to go towards population versus habitat components.
- Group decided that we do need to put equal emphasis on population component, can't make assumptions about habitat without knowing about the population.
- Given that we're on the edge of the range of the population, not unreasonable to expect the possibility of local temporary extirpations; need to ensure habitat and options are available to reinstate populations if that occurs.
- Saving known or recovery sites should be a high priority objective:
    - however, consider that "known sites" where owls have been found do not always represent breeding habitat;
    - even for areas identified as breeding habitat we are assuming that nest sites are producing young but no documentation on this [Editors' note: Nest site production data are documented on the B.C. Ministry of Water, Land, and Air Protection Spotted Owl Database];
    - imperative that we define what critical habitat is, which is also a responsibility of the Spotted Owl Recovery Team.

Question 2 What factors influence the population?

- Competition from Barred Owls:
    - Direct competition with Barred Owl for space and prey;
    - Decline of Spotted Owl population in good habitats corresponds with increase in Barred Owl populations;

    - This is a hypothesis that has yet to be tested; model may be able to test;
    - Do we need to examine Barred Owl distribution to learn more about habitat suitability for Spotted Owls? Limited information is available on Barred Owl distribution;
    - Barred Owl is naturally increasing its range and abundance – they are not using distinctly different areas and seem to occur everywhere;
    - Can't identify any habitat manipulation solution to reducing competition;
    - If Barred Owl competition is confirmed to be the primary factor influencing Spotted Owl declines, consider option of reducing number of Barred Owl – targeted reductions.
- Small Population Size:
    - Because we have such a small population size, we don't have much of a base for re-establishing the population;
    - What population size should be input into the model as the starting point? Ten years ago?
    - Appear to have huge landscapes with suitable habitat but no owls. Can we get the model to tease out the importance of habitat?
- Productivity and Survivorship:
    - During earlier presentations, Myke Chutter indicated that we have this information available for British Columbia (Note from Myke: We do have some limited data on productivity and some birds have been banded);
    - Currently using survivorship data from Washington in the model which is considered best-available information. Too few owls in British Columbia to use our data;
    - Presentations from yesterday indicated there is a gradient in adult survivorship, with higher survival in the wetter regions but lower productivity, and lower survival in the drier regions but higher productivity;
- Capable versus Existing Habitat:
    - If all other factors could be held constant, what is the importance of habitat?
    - What population size should be input into the model as the starting point? Ten years ago?
    - Need to consider what areas have the capability of providing future suitable habitat;
    - Ensure both reproduction and adult survivorship habitats are available – further definition of these two habitats needed;
    - Can we look at historically active sites to establish a "site image"? Alton Harestad and Irene Manley are developing nesting site descriptions.

Question 3 What is a sustainable population? What, where, and when?

- Difficult to define thresholds for enough habitat to sustain the population (30% productivity? 50%?).
- Need to define our level of certainty associated with any threshold statements.

Question 4 How important are social cues to behaviour?

- Social cues are very important to promote settling of dispersing owls.
- Hybridization with Barred Owl is a function of isolation that reduces mate availability.

Question 5 Do we know about mortality and survivorship related to dispersal?

- Group did not have time to address this question.

Question 6 How important is it to include West Nile Virus as a factor in the model?

- This could be a significant factor influencing the population given that small population sizes have the potential to be wiped out entirely; however, do not have time to contribute to how to proceed with incorporating into the model; also recognize difficulty and high level of uncertainty in defining model parameters for this.

- Is there any information on what population size is likely to be sustainable if exposed to the virus?
- Group decided that if West Nile Virus can be incorporated, model should do so, or at a minimum, address it within the assumptions section.

Question 7 Should the model include population augmentation scenarios?

- Group decided that augmentation is a later step after other options have been examined.

Summary

- Owls in British Columbia should be considered a distinct population, which is then subdivided into wet versus dry ecotypes (i.e., not 2 subpopulations, just two parts of a range);
- Main factors influencing the population include:
  - competition from Barred Owls;
  - small population size;
  - productivity and survivorship;
  - capable versus suitable habitat.
- West Nile Virus could be a significant factor influencing the population given that small population sizes have the potential to be wiped out entirely. A lot of uncertainty exists around the virus It should be incorporated into the model if possible, or at a minimum, addressed within the assumptions;
- Augmentation should be considered after other options have been examined.

Full Forum Discussion

- Lamberson paper will provide information on suitable indicators (indicators for what? Jared to supply this).
- Ensure that differences in reproduction and survivorship between wet and dry ecotypes are applied in the model–data presented by Dale Herter yesterday.
- Should include fire as an important factor that will influence the population.
- West Nile Virus influences birds of prey whose range is limited to northern areas more than those whose range includes southern areas.
- If we implement augmentation, need to have a mechanism to evaluate it.
- Don't know how captive breeding will work–success rate unknown so can't put in model, but can test the extremes (worst- and best-case scenarios).
- Can we use the model to define critical habitat? Potential to use to rank importance.
- Population initiation: how many owls do we use at the start of the run:
  - start with known active sites;
  - predict where owls might be based on habitat;
  - address uncertainty: Do we know how many floater birds there are? Jared Hobbs presented 6% dispersing breeders as the approximate rate; with small population size, may be higher percent dispersal; the younger the owl, the more likely it will disperse, moreso in males than females.
- Is there a reason to think the B.C. population is genetically distinct? No, some gene flow occurs, extent unknown (gene flow with U.S. populations?).
- Model capable of removing patches and evaluating connectivity effects on population.
- Should we further explore the hypothesis that Barred Owls are the main threat and determine

how to address this with the model? To model Barred Owl habitat, include variables that identify riparian areas, distance to riparian, and slope.

- Need to make assumptions about the effects of Barred Owls on demographics.
- Barred Owls may not use steeper slopes, need to identify different habitat use patterns.
- Are dynamics different given that Barred Owls have been in British Columbia longer than Washintion? Have B.C. Spotted Owls already adapted to co-habitation with Barred Owls in some parts of the province? Could that explain why they have winked out in some areas, but managed to survive and breed successfully adjacent to Barred Owl in others?

Group C: Habitat Enhancement

Pre-defined Questions

Handout

Habitat Enhancement Break-out Groups

1. ***Is it feasible to get quality habitat quick enough through stand management to meet timelines necessary for recovery?***
   - What conclusions can we draw from current stand management strategies?
   - How do current habitat management strategies link with time frames for population recovery?
   - What are the time frames for habitat enhancement or creation?
   - Is habitat enhancement feasible in the short term, or is it only a long-term proposition?
2. ***What areas and types of stands can be enhanced?***
   - How much does enhancement depend on site productivity and climate?
   - Is enhancement possible on the northern extent of the range?
   - What stand attributes should be enhanced?
3. **What are the management implications of habitat enhancement?**
   - Does enhancement require change in harvest rotation length?
   - Conversion from even-aged to uneven-aged management?
4. **Is habitat enhancement appropriate for some but not all Spotted Owl needs? (e.g., Can foraging and dispersal habitat be created or enhanced (versus nesting habitat)?**
   - Will the structure of the forest increase the prey base, and allow it to be accessible to Spotted Owls?
   - What effect will enhancement have on Spotted Owl predators and competitors?
   - Is habitat enhancement appropriate where social cues have resulted in use of suboptimal habitat?
5. **What are the costs and benefits to industry are associated with habitat enhancement?**
   - Is it appropriate to model the extraction of older suitable stands if younger stands (e.g., 100 years) can be enhanced to mimic older stands?

Group Participants

Kathie Swift (facilitator)
Kym Welstead (note-taker)
Glenn Sutherland (modeller)
Paula Swedeen
Bill Rosenburg
Shawn Hilton
Chris Fletcher
Kevin McKelvey
Brian Nyberg
Brian D'Anjou
Jerry Kennah
Rick McKelvey
Bob Peever
Glenn Farenholtz
Andy Miller
Roberta Parish
Brian Clark

Group Discussion Notes

Question 1 Is it feasible to get quality habitat quick enough through stand management to meet timelines necessary for recovery?

- We do not have a typical situation as Spotted Owls (SPOW) are at the northern extent of their range.
- We are dealing with a small population in British Columbia that is susceptible to stochastic events.
- The speed of recovery of habitat depends on the starting conditions.
- Habitat enhancement is something for long-term planning and will not rescue the owl now.
- Investing for owl habitat that might become suitable only after 30 or more years. It is a questionable investment in money: Will the SPOW be gone by then?
- The hybridization issue is a concern: What if we are enhancing habitat for the competitor and not the SPOW?
- We should be looking at the best management practices of biodiversity and not be enhancing just for the SPOW;
- However, we need to move forward with the assumption that the SPOWwill still be here.
- Landscape management can act as a buffer for extirpation.

Is there evidence that habitat enhancement has been successful? Can habitat be enhanced?

- We need to determine if there is evidence that habitat enhancement is successful and whether this evidence can be applied to British Columbia.
- We need to determine what structures are important to mimic and what should be left behind during harvesting.
- In Washington and Oregon, SPOWs will nest in young harvested stands with 60-year-old trees—so yes, foresters feel that they can restore stand structures that attract SPOWs.
- It is uncertain but likely that enhancement in the United States is worthwhile and may accelerate movement of owls into the habitat.
- However, there is still an assumption that the stands will mature as prescribed.
- In the United States, populations of SPOW are still declining–they have not had enough time for the stand manipulations to take effect. Habitat augmentations have not had enough time to be reflected on for improvements in SPOW populations.

Can we transfer habitat enhancement data from U.S. to B.C. populations? Are there differences in prey base between B.C. and U.S. populations? In addition, does this influence habitat enhancement options?

- It is important that the prey base is similar between the United States and British Columbia or the U.S. model of habitat manipulation will have limited value.

- Preliminary data from Lillooet indicate that flying squirrels are an important prey for B.C. populations; bushy-tailed woodrats and deer mice are also consumed (Shawn Hilton).
- Diets do seem to be reasonably similar between the populations.
- There is concern that habitat is more fragmented in British Columbia than in the United States, which may alter management options.
- Very little is known about the biology of the SPOW or the habitat requirements for B.C. populations, and each site seems to be different in British Columbia. Perhaps we should use the U.S. data for guidance as we know so little here.
- There is uncertainty in what we know about SPOW habitat in British Columbia. However, we can't wait until we have more data—is there a way of refining our uncertainty to reduce error?

Question 2 What areas and types of stands can be enhanced?

- There is agreement that existing occupied old-growth stands should not be enhanced, and enhancement should be done in non-occupied sites in British Columbia by attempting to convert non-habitat or disturbed habitat into potential habitat.
- Stand types and possible suggestions for management options:

    1. Old growth: currently occupied – no entry – leave it;
    2. Potentially useful old-growth stand but stand density is too high (e.g., 1,000 stems/ha): may require thinning (SPOW prefer 400–500/stems ha) and then leave some time to recover;
    3. Intermediate: for 30–50 year old, recently managed stands, should set up enhancement early. Stands with areas of natural legacy structure are easier to enhance and have a higher probability of success;
    4. Recently managed and fire-originated stands: clearcut stands require intervention, manipulations should be started early. Stands should be enhanced to increase the biodiversity value in general.

- There may be different habitat enhancement requirements between wet and dry areas—this issue has been researched in the United States.

Where is habitat enhancement most likely to be successful?

- The conversion from clearcuts to old-growth attributes will take much longer than leaving old-growth attributes in second-growth stands—management should occur when the stands are harvested and legacy elements should be left.
- Second-growth stands with legacy elements are more likely to be used by owls, reduce recovery time, and have higher probability of enhancement success.
- It is less possible to take a clearcut and convert it into a stand that has old-growth characteristics.
- There is evidence from Washington that clearcuts will never return to owl habitat without silvicultural manipulations.
- It is a gamble to leave plantation stands—treatments should be done early or after harvest.
- Stands created with more complex structure seem to be more successful for SPOW.
- The model will help to simulate different cut-types and rates of recovery.

Question 3 How is habitat enhancement done operationally? What are the physical limitations to habitat enhancements options?

- The Washington habitat has a different topography; British Columbia may have more limitations regarding habitat enhancement.
- There is uncertainty over what is possible at an operational level.

- Enhancement is most likely on tracker available ground (ground where tracker can be used—generally more level terrain).
- However, we do not have a lot of tracker ground in British Columbia.
- The model is across the TSA but should prioritize all available tracker ground and should target habitat within a certain range of suitability.
- Enhancement is not likely possible on steep slopes—many of these areas are already left unharvested.

Question 4 What kinds of habitats should be enhanced?

- All potential habitat types used by the SPOW (foraging, roosting, nesting, wintering) are candidates for enhancement.
- The habitat management group should define what habitats should be enhanced or prioritized for enhancement.
- Each required habitat will have different outputs or requirements.

Question 5 What are the costs and benefits to industry associated with habitat enhancement?

- The timber value has to make habitat enhancement worthwhile.
- Should describe what is theoretically possible for habitat enhancement, and have a range of possibilities including cost estimates.
- Licensees will not do enhancement unless they at least break even—there is a need for incentives.
- Stands 50–120 years old with some legacy elements left behind are more financially viable to manage.

Parking Lot (Issues noted but not discussed due to time limitations)

This is a complementary model and not a competitive model.

Knowledge gaps

- Is there evidence that there are owls in the 90-year-old stands? Unknown, this was not the priority for surveys in British Columbia; however, they are in the United States. Perhaps we should be surveying these sites in British Columbia.
- Are we creating Barred Owl habitat through these habitat enhancements?
- Information related to growing rates of old trees (>150 years).
- Knowledge of breakage and decay of older stands is limited.
- Stand structure that SPOW require is unknown or uncertain.

Summary

- Habitat enhancement is highly speculative.
- Experiments from the United States are helpful but we need to be careful in translating it to the B.C. environment (e.g., time elements).
- There are four conditions where we have options:
    1. Old growth: not worthwhile for habitat enhancement;
    2. Marginal stands with lots of legacy elements: we can use simple enhancement techniques and can see the benefits quickly;
    3. Intermediate-aged stands (50- to 140-year-old stands): these appear to be accelerated by 20 years with habitat enhancement;
    4. >40 years old: silvicultural activities should be tried to increase the biodiversity value in general; long-term benefit are outside of the terms of the recovery plans for SPOW.

- Several attributes influence habitat enhancement including:
    1. stand age;
    2. stand density;
    3. slope;
    4. history of disturbance (legacy);
    5. proximity to existing habitat.
- Our strategy should be to do a sensitivity analysis around the proportion of types of stands that can be manipulated and to see how or what difference it makes before we invest in habitat enhancement activities.

Full Forum Discussion

- Separating different types of habitat uses (e.g., foraging, nesting) is important. As some activities may enhance forage in younger stands versus nesting habitat, it's important to consider habitat enhancement for each habitat use and options may differ between stand types.
- Role of fire in these stands and fuel management should be considered:
    1. Opportunities when fire has happened—looking into the future;
    2. Current fuel loading in drier stands—landscape issues—fire management.
- Concerns about creating good Spotted Owl habitat, which in turn promotes Barred Owls.
- Landscape management issues to enhance habitat—considerations of this in the United States—but British Columbia has different "spaces" at the landscape level that will have to be investigated.
- Long-term approach with longer rotations—U.S. research may be useful.
- Research in the United Kingdom may also be helpful as they are doing landscape restructuring work for recovery of forest bird species. But the biophysical constraints are very different.
- There must be integration of all planning activities going on in the TSA; there is a need for land use planning, including visual quality, etc.

Data Questions

The modelling team has identified the following high-level strategic data questions that need to be addressed to further the model process. The break-out groups were intended to address these questions in addition to the above described question sets. However, the limited time available, and extensive scope of the questions sets meant that the data questions were not discussed. A focus group will convene in the future to address these questions as well as additional questions that have arisen as a result of this workshop.

1. ***If we do not have full landbase data sets is it appropriate to run a simpler model in the Soo and Cascades TSAs, or should we find the lowest common denominator for the population component and run at the same level throughout all three TSAs?***

2. ***If we do not have full data sets for all three TSAs, could the more detailed data for the Fraser TSA be used to answer some questions but not all? If so, which ones?***

3. ***Can we accept and use the available data sets, and agree to accept the outputs of the model based on these data sets?***
    - How sensitive will the final outcomes be to the resolution and vintage of the landbase data sets?
    - Is the quality of the data going to affect the acceptance of the model's final outcomes?
    - What level of error or unreliability is acceptable?

RESPONSE BY MODELLERS

GLENN D. SUTHERLAND, S. ANDREW FALL, AND DAN O'BRIEN*

The discussions in the Break-out groups, and in the Full Forum summaries clearly underscore the twin challenges facing the modelling team:

1. The state of knowledge about SPOW ecology, the species' likely responses to habitat change, and the influence of both habitat and non habitat mediated causes of decline is patchy;
2. The present need to use whatever information we do have in guiding the design of the recovery strategy requires that we cannot hold back until knowledge gaps are filled.

Therefore, ensuring that the modelling framework remains constructed of a number of relatively simple components, and that the assumptions in each are well documented, is critical both for supporting the overall scientific basis of the model results, and for the utility of the scenarios in advancing options for recovery.

In this response, we focus less on reiterating the details of the group discussions (already well laid out in the preceeding section). Details presented there will help considerably in refining the habitat assessment and the population projection and connectivity components of the framework. We will instead briefly identify the process we envision for further model refinement and development, in light of these discussions.

1. *Relative "development weight" of the different components.* The discussions indicate that the population projection and connectivity components of the model need to be well thought out and given as much development weight as the timber/habitat management and habitat assessment components. Clearly, uncertainties about other influences on population viability (e.g., Barred Owl competition, disease) along with concerns about habitat fragmentation. Assessing these requires that at least simple hypotheses for these factors be included in the model structure, and "what-if" scenarios be designed to explore the effects of these factors on outcomes.
2. *Representation of uncertainty.* Many information gaps were identified in each of the discussions, many of which will remain unfillable during the time frame of this analysis. These include study of fine-scale habitat attributes required by owls at nest-sites and territories in British Columbia, some specific population and movement parameters, effects of habitat enhancements on future use of managed landscapes, etc. The general "probabilistic" approach of the framework will help retain the influence of uncertainty (expressed as variance) in model parameters on the overall projected outcomes. We will need to ensure that such variation is estimated reasonably, and documented. It is more problematic to assess the influence of poor or incorrect hypotheses on outcomes (errors in model structure). While one approach to this form of uncertainty–testing alternative model designs against each other–is possible in principle, time constraints will prevent us from doing much of this type of analysis. The core modelling and research team will need to understand the strength of the component model hypotheses and associated information that will parameterize the model, and to consider the effects of errors in interpreting outcomes. "Uncertainty" is usually difficult to communicate to decision makers, who will need help in interpreting results that will inevitably contain uncertainty. The core modelling and research team will need to address this communication challenge while developing the model, to make sure that indicators are designed to communicate results containing both certainty and uncertainty.
3. *Data assembly and quality.* Some aspects of SPOW ecology will not be well captured by any data sources presently available—they are too fine-scale (e.g., small remnant patches of fire-veteran stands) to be predicted well by the coarser-resolution data that is available. Nonetheless, there are

reasonably up-to-date data coverages (including VRI and updated FC) for the known range in British Columbia. (Note: Since the workshop, considerable effort has gone into acquiring and evaluating these data sets. We now think that our ability to develop a consistent management and habitat modelling approach across the species' range in British Columbia is considerably better than was believed at the time of the workshop.)

4. *Scenario development.* As discussed, the breadth of questions surrounding recovery of this species in British Columbia suggests we follow a two-phase scenario assessment: (1) learning (experimental) scenarios to study model sensitivities and regions of plausible outcomes; and (2) feasible policy-oriented scenarios focused on management options for designing the recovery plan. While the number of scenarios in the first phase is unknown, the number in the second phase is likely to be 4–6. To work towards this end, a set of focus groups for scenario development and evaluation will be set up.

Last, the modelling team is very grateful to all the workshop participants for their input, ideas, and data. The findings of the workshop helped to identify areas where more digging is needed, where information gaps could be filled, and equally important where information could not be used (e.g., extrapolated from U.S. studies to British Columbia), or were unknown. We are confident a better assessment framework will result from this input. Our goal is to make the model framework and its use in the planning process as transparent and collaborative as possible. Our thanks to all.

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Session 4

Socio-Economic Analysis and Scenario Development

SOCIO-ECONOMIC ANALYSIS AND REQUIREMENTS PANEL

Socio-economic Considerations

DAVID CUNNINGTON AND RICK MCKELVEY*

National policy on socio-economic considerations under SARA is not yet available. A working group was recently established with the intention of producing policy recommendations. A few points concerning socio-economic considerations, however, are reasonably well established in the national concept of recovery planning.

Socio-economic considerations occur at three main points in the recovery process. First, there is an inherent consideration of socio-economic concerns at the point of legal listing, when Governor in Council decides whether to add a species to SARA's legal list. Legal listing implies political accountability for the subsequent recovery process. Second, socio-economic considerations are taken into account at the Recovery Action Plan stage of recovery planning. Third, five years after a Recovery Action Plan comes into effect, the Competent Minister must report on the plan's socio-economic impacts.

Socio-economic considerations at the level of the Recovery Action Plan should take a number of points into account. SARA requires that the Recovery Action Plan include "evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation." This should include social aspects, such as society's perceptions of the species, at local, provincial, national, and international levels. It should include positive and negative economic aspects, and consider the costs of not recovering the species, which may include market campaigns and trade restrictions. Finally, the analysis should consider the effects of opportunities gained or lost by different courses of action.

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Socio-Economic and Environmental Assessments for Species at Risk: Spotted Owl, a Case in Point

NANCY SOUTH AND GLENN FARENHOLTZ*

In the context of the *Species At Risk Act* (SARA), a socio-economic and environmental assessment (SEEA) is a decision-support tool that keys into the social, economic and environmental benefits and costs of land use and management plans developed to recover, in this case, the Northern Spotted Owl. Including socio-economic information and stakeholder interests early in the development of a recovery plan helps the recovery team define and describe a set of options and alternatives that outline the full range of benefits and costs for decision makers' consideration.

The B.C. Ministry of Sustainable Resource Management has developed and/or uses several key peer-reviewed tools to provide socio-economic analysis in support of land use decisions. These are:

1. *Socio-Economic and Environmental Assessment for Land and Resource Management Planning in British Columbia: Guiding Principles*, July 2003 *http://srmwww.gov.bc.ca/rmd/ecdev/analysis/index.htm;*
2. *Socio-Economic and Environmental Impact Assessment for Land and Resource Management Planning in British Columbia: Guidelines for Multiple Accounts Analysis,* Draft 2001 *(link to be updated . . .);*
3. *Economic Building Blocks: Profiles of British Columbia Land and Resource Based Businesses,* March 2003 *http://srmwww.gov.bc.ca/rmd/ecdev/analysis/building_blocks.htm;*
4. *British Columbia's Heartland at the Dawn of the 21st Century: 2001 Economic Dependencies and Impact Rations for 63 Local Areas,* B.C. Stats, January 2004 *http://www.bcstats.gov.bc.ca/pubs/econ_dep.htm.*

The assessments developed under these tools focus on supporting resource allocation and efficiency decisions made by statutory decision makers. These decision makers can then effectively weigh the trade-offs associated with impacts resulting from the land use decision, knowing the likely significant benefits and costs of a plan on other interests in the plan area.

A socio-economic and environmental assessment uses the following framework in accounting for social, economic, and environmental values:

1. **Economic development interests**, both regional and provincial, accounting for direct, indirect. and induced jobs and income by sector;
2. **Social and communities interests**, expressed in the form of impacts on population, number of jobs, and income levels, as opportunities for resource-based industries, as well as the general well-being of the communities;
3. **Net resource value**, expressed in terms of economic rent captured by industries and labour; can also consider values of non-commercial consumer surplus (the extra value people would be willing to pay for the resources and the services they provide);
4. **Environmental values**, both regional and provincial, that are expressed in terms of a risk-based assessment of key indicators based on the options and scenarios developed under the plan;
5. **Specific aboriginal concerns;**
6. **Implications to government finances**.

According to the B.C. Stats community dependencies report (2004), the Spotted Owl recovery area is relatively diverse in its economy and residents' incomes are not highly dependent on forestry. The point here is that one must dig into the numbers to tell the full story.

At first blush, most people in communities within the recovery plan area are dependent on public sector transfer payments and non-employment sources of income. In the few more diverse communities, tourism, forestry, construction, and other retail industries are the dominant income sources. Despite the variation, the relative level of allowable annual cut (AAC) is equal or greater to the potential harvest in the non forestry dependent communities. Digging a little deeper, the strength of their diversity is likely due in part to the service industries that employ people that live there in construction and tourism jobs that are dependent on their proximity to Vancouver and Whistler.

In other areas, public sector employment, making up over 55% of the household incomes in the area, can be viewed as a provincial redistribution of tax dollars that does not directly contribute to income-generating jobs at a provincial level. These public sector jobs provide for indirect or induced employment, but their work is not dependent on the resources of the area, and their likely spin-off coefficients are minimal compared with the export-based sectors. The lesson here is to be careful with the numbers as reported.

Employment coefficients and multipliers require careful interpretation. In an SEEA, they are used to reflect the sensitivities relating to local, regional, and provincial employment and *do not* translate into actual individuals who may or may not gain or lose jobs as a result of the plan. An SEEA expresses where the existing dependencies are, and can be used to ascribe a relative level of negative risk or positive gains to an interest group associated with the recovery plan. The creativity in developing the plan can begin here, by examining means for mitigating the risks associated with the land use decisions and generating alternatives for decision makers to consider.

SARA requires an evaluation of the socio-economic costs of the plan, and the benefits of its implementation. Benefits can be difficult to define, as there is little certainty in projecting growth, particularly for potential opportunities that require entrepreneurship, different skill sets, and/or a cultural shift from the dependencies on resources built up over time. Plans can describe benefits to species at risk, mitigate potential hydrologic impacts, increase certainty on the remaining landbase, and build relationships between interest groups to help minimize the negative impacts resulting from a land use conflict. Licensees may gain access to further social licence to harvest if they are perceived by the market as being ecologically sensitive and environmentally friendly, directly affecting shareholder values and employee morale.

The recovery area includes significant forestry, mineral, industrial mining, tourism, and residential recreational hunting and fishing interests and values. For example, in forestry, harvest levels in the timber supply areas and tree farm licences of the area describe a dependency of over 11,000 people (woodlands, manufacturing, and transportation industries), and generate over $30 million in stumpage revenues to the Crown between the Chilliwack and Squamish forest districts alone. There are also over 20 industrial mining companies, which if each generates an average of $1 million in sales every year, could employ over 400 people in the local industry producing aggregates, clays, and limestone. A quick browse of hunter activity shows that there were over 3,000 resident days hunting black bear alone, and over twice that number of hunter-days associated with deer, grizzly bear, cougar, and birds. Most of these sectors have significant interests in the recovery plan area, and are likely due to the pressures experienced by the area being so close to a high population centre such as the Lower Mainland.

One of the goals of your workshop is to develop innovative approaches in species recovery plans—in economics that translates into who is willing to pay, what property rights (in the form of leases, licences, and quotas) must be described, who administers and enforces those property rights, and what benefits accrue to British Columbians by any conservation initiative or industry. Some values cannot be quantitatively defined, and therefore must be considered in their most natural units (i.e., hectares of critical Spotted Owl habitat as an indicator of risk to the species) such that decision makers can impart a relative value in their decision-making processes.

What has not been clear in most planning processes is an evaluation of the appropriate time frame to adopt the strategies to mitigate adverse social and community impacts resulting from the plan. For example, timber supply analysis may help to define a realistic step-down of harvest levels such that potential impacts to forestry-dependent communities (such as Lillooet) are minimized and most, if not all, of the existing critical Spotted Owl habitat is maintained. If the timber age and operable profile is robust enough, and protected areas are flexible and can move into areas that better reflect the habitat needs of Spotted Owls in the future, there may be opportunities to minimize the impacts to other resource users where they are most dependent.

For decision makers to be able to evaluate these trade-offs, they need to know what they are buying in the way of certainty in maintaining Spotted Owl populations by conserving habitat, how sensitive other social and economic interests are to those decisions, and what kinds of opportunities there are in spreading out those impacts to allow communities the time to adapt to the tenure and land use changes proposed in the plan.

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Biography: Nancy South is Manager of Revenue and Economics with the B.C. Ministry of Water, Land and Air Protection, Environmental Stewardship Division. Before moving to WLAP in 2003, Nancy was Manager of Economic Analysis for the B.C. Ministry of Sustainable Resource Management where she was responsible for socio-economic analysis in all land use plans. She has also been responsible for economic issues in tourism, fisheries, and women's equality. Before re-joining government in 1994, Nancy taught economics at the University of Victoria and Trent University in Peterborough.

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Biography: Glenn Farenholtz is an economist and professional forester with the B.C. Ministry of Sustainable Resource Management, Economic Development Branch. Since 1985, he has worked in operational forestry with the forest industry in the interior, for government as a hydrologist, manager, and treaty negotiator, and as an independent consultant to both industry and government. Glenn currently works supporting land use decisions developed under Land and Resource Management Planning (LRMP) for the province of British Columbia and is based in Victoria.

Comments and Questions Concerning Socio-Economics

C: Obtaining socio-economic consultation. Government staff doesn't have resources on their own, should work hand in hand with consultants. About 6 months of work to pull together. Requires hiring an economic consultant. It is the Spotted Owl Recovery Team's responsibility to hire someone. It would be wise to find someone that can work with the recovery team. Tools and reasonable guidelines are currently available, and tools can be developed to help groups through the process and hopefully minimize costs.

C: Putting a value on extirpation. The benefits of the implementation of SARA don't have to be socio-economic. They don't have to have a value associated with them. The value can be qualitative. You may not want to quantify the value—e.g., culturally modified trees (CMTs). Their value to First Nations is invaluable and we shouldn't put a price tag on them. It may be the same with Spotted Owl habitat. An advantage of decision analysis framework is that it has economics and other variables included. Qualitative values can usually be captured in such a way that they don't just disappear. There may be an opportunity to bring socio-economic specialists into the process.

C: Value of species. Do we assume that all species native to Canada are of equal value. There is a blanket value regardless of species. Ministry task force looks at what people would be willing to pay for species recovery. It is nice to have a number (binoculars sold, hikes taken, etc.)

C: Aligning the current and future trade-offs. Economic forecasting doesn't cover long time frames (e.g., 200 years). We can speculate a little, layout a number of scenarios, and talk in general terms of what the outcomes might be. Anything past 5–10 years isn't very useful. Looking at log market cycles can assess industry potential. Are we going to impact on that potential?

C: Examples of how the socio-economic aspect has been included in other processes (e.g., other recovery teams) would be useful. Some work has been done through Water Use Plans. It involved the development of a trade-off matrix that included non-quantifiable items.

Habitat & Population Management Scenario Development—Working Session

To examine options for managing the Northern Spotted Owl and their habitat, the modelling team is developing several scenarios that can be run to test the relative influence on populations, habitat, and socio-economics. A multitude of issues need to be considered, and the modelling team has outlined some of these issues in the handout below. This session was conducted to solicit discussion about the issues, determine potential solutions, include additional questions that may not have been considered, and outline the most appropriate scenarios that should be run through the model.

Pre-defined Questions and Direction

Handout

Potential Scenarios

Scenarios could be considered under the following themes:

1. Current management under TSR
2. Habitat recovery and enhancement
3. Habitat protection
4. Population augmentation

Issues to be Discussed in Designing Scenarios:

- How much habitat is enough?
    - Is 67% suitable habitat within 3,200 ha enough?
    - Should we protect 100% habitat within designated Spotted Owl areas?
- Can we maintain suitable habitat?
- How do current and future strategies relate to natural disturbance patterns (fire, insects, etc.)?
- What are the opportunities for multiple resource uses in suitable habitat?
- Can we dynamically manage areas for Spotted Owl? Can all or some of the currently inactive areas be released from Spotted Owl management?
- Can SRMZs/LTACs be reconfigured to maintain suitable habitat while maintaining the timber harvesting landbase (THLB) (and AAC)?
- Can better use be made of suitable habitat in protected areas (through translocation) thus releasing THLB?
- What would habitat enhancement give us over time (how much time, how much habitat)? Combined with translocation, would it allow us to maintain or increase current THLB (or AAC), now or in the future?
- To what degree will the inoperable landbase or non-contributing/otherwise constrained landbase contribute to managing Spotted Owls?
- What are some different economic options around population augmentation/habitat protection, given that both have heavy economic implications?
- Appropriate time frames?
- Can habitat be protected in perpetuity?
- Can habitat be reduced without compromising the owl?

Full Forum Discussion of Scenario Design Issues

Who are the local players, management decision makers?

- Spotted Owl Recovery Team–reports to Bruce Morgan (Biodiversity Branch, WLAP);
- Chief Forester;
- Cabinet - provincial and federal (SARA);
- Minister responsible for the species.

What is the main information required from the model?

- Risk and impact levels associated with various scenarios with gradients of options;
- Volume harvested by management unit (MU) is the primary socio-economic output;
- Currently missing data outside of the Fraser TSA;
- Group needs to determine what is the minimum version of the model that we need to run (i.e., the simplest version).

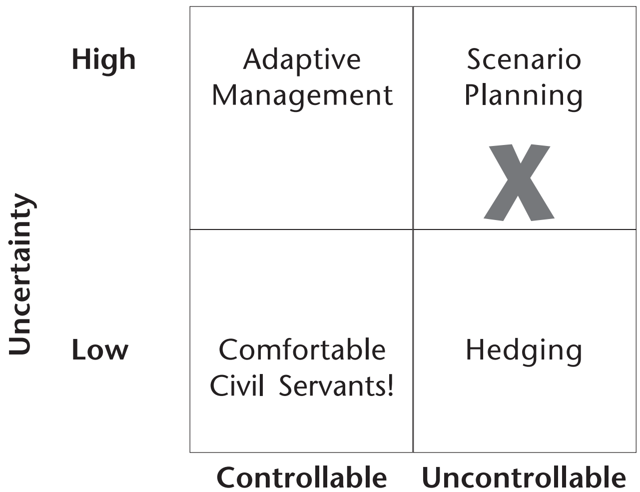

FIGURE 2 Setting the context for scenario planning.

Population Comments and Questions

Q: *Is downlisting possible?*

Q: *What size of population can we expect under different conditions?*

C: 250 adults is a standardized number for downlisting under COSEWIC that is most relevant to the criteria under which the Spotted Owl was designated. If this is reached, the species can be downlisted from Endangered to Threatened. If this level can be sustained and threats removed, it could be further downlisted to Special Concern. It's unlikely it could ever be completely delisted.

C: Primary goal is to achieve a viable self-sustaining population. SORT also accepted that 250 adults would be necessary to downlist the species to threatened.

Q: *What does it take to reach 125 pairs?*

- Is it possible under some conditions and not others?
- Did the landscape ever support 125 pairs? YES
- What recruitment rates are required to reach 125 (i.e., 1 owl per year, 2 owls per year)?
- Would require 125 territories; under SOMP currently have 101 so not infeasible to reach.

Q: *Is the habitat capable of supporting 125 pairs?*

Q: *Is there enough of a population base to reach 125 pairs?*

Q: *What does it take to have habitat available for 125 pairs?*

C: Main uncertainties and model sensitivities are with demographics.

Q: *Where is habitat recruitment most likely to occur?*

Q: *What time frame will the model forecast to? (e.g., 3 generations time span?)* ***A:*** No, only applies to target populations.

Q: *What is the minimum component of the model required to address these questions?*

Landscape Change Comments and Questions

C: Landscape changes due to:
- forestry;
- tourism;
- mining;
- pipelines;
- roads/highways/railways;
- urban development.

Q: *What would the cost be and what management options are there to generate enough habitat to maintain 250 individuals?*

Q: *Where is the habitat now and where will recruitment most likely occur over time?*
- Reconfiguration options;
- Can we maintain the current population under existing conditions (SOMP and existing protected areas)?

Q: *Rate of harvest versus pattern of harvest.*

Q: *How does the management of owl fit with stand- and landscape-level biodiversity protection and management?*

Q: *What level/tools of change at the landscape-level impact timber supply? The TSR process? TSR assumptions versus owl/habitat impacts.*

Q: *Impact of different management styles and jurisdictions on landscape (i.e., fire suppression, fire management)?*

Q: *Impact of fragmenting Crown land through ownership and its impacts on habitat/landscape?*

Q: *Impact of increasing protected areas and influence on owls?*

Q: *Effectiveness of existing management choices (e.g., protected areas)?*

Q: *How did we get to where we are and what were the pressures the owls were under at that time?*

Management Questions

- What are the most important critical habitats (foraging /roosting/nesting)?
- What degree can we maximize other benefits from the protected habitat (e.g., other species)?
- Can we reconfigure what we have already?
- Currently we have 363,000 ha managed for habitat, but only 50% good owl habitat;
- Is the recruitment of habitat faster or slower than the owl population growth?

- Should we delist some areas that are less suitable (other 50%)?
- Will these unoccupied sites be used by future owls as population increases to 125 pairs?
- Should the socio economic components be included in the model or be looked at once the outputs have been given?
  - Model includes road building, an indicator that can be used for cost analyses;
  - Scenarios consider the amount and timing of road building;
  - Forecasts timber and habitat supply;
  - Should it include mining?
- How much habitat do we currently have?
- How much habitat would we have under best management?
- Trade-off to timber supply.
- Target of 125 pairs is a habitat question!
- How many owls can the current habitat support?
- What new areas can be protected to ensure connectivity to recruitment areas?
- Foraging habitat can be readily recruited, nesting habitat cannot [Editor's note: This was different from the conclusion of the habitat enhancement group].
- Are currently empty LTACs acting as connectivity and recruitment sites?
- Management options: Are there thresholds?
  - protected areas;
  - fire suppression;
  - regeneration (habitat and owls);
  - intensive management;
  - timber supply;
  - patterns and rates.
- To what extent do owl habitat requirements overlap coarse-filter biodiversity requirements?
- What happens when we need to deal with multiple land ownership? Impact of different jurisdictions (e.g., parks, Crown lands)?
- Management options differ with varying degrees of flexibility.
- In protected area – what is happening to the owls there?
  - potential for immigration;
  - closed versus open populations;
  - can these support owls?
- If populations within protected areas are declining, is it feasible to obtain a viable population or do we need to augment?
- Cost within the timber supply:
  - road building;
  - cost trade-offs.
- Some "suitable" habitat is not used by owls – can owl be "introduced" or will they return naturally?
  - unknown reasons for a lack of owls in suitable habitat;
  - this cannot be answered by the model.

Full Forum Discussion of Potential Scenarios

Scenario components:

1. scale – time and space;
2. objective/questions;
3. decision support;

Potential scenarios (suggested by the SORT)

1. Protected Areas only: no resource extraction; stop habitat use/loss.
2. SOMP 67%: Status quo or current management – LTACs have 67% protected in theory (50% are under this level).
3. SOMP 100%: 100% of LTACs identified in SOMP is protected.
4. SOMP (67%) and new LTACs.
5. SOMP (100%) and new LTACs (scenario recommended by SORT).
6. SOMP (100%) and new LTACs , add connectivity.
7. SOMP (100%) and new LTACs, add MACs.

8/9. Consider occupied versus unoccupied in all ranges, and new acquisitions for other areas.

10. All suitable habitat protection (NGO recommended scenario).
11. SOMP at saturation.
12. Increase AAC by 20%.
13. Optimal habitat distribution, assuming:
    - no replacement;
    - with replacement.

Considerations

- Trade-offs and timing to bring species to recovery.
- Set of conditions (range of possibilities).
- Impact of climate change on timber supply.
- Scale issue: consider whole owl range or just B.C. portion?
- Scale must be run on both Fraser and entire range.
- Temporal issue:
    - projections over time (e.g., 20 years, 40 years, 1,000 years);
    - question it is intended to answer.
- What decision does the scenario support? Learning?
- Recovery decision? Policy decision – allocation of land.
- Possible other issues include:
    - hydro lines;
    - urban expansion;
    - parks;
    - watershed;
    - natural events such as fire, beetles, wind throw, etc.
- Increase or decrease in allowable annual cut.
- Control of predators.
- Fire suppression, yes or no?
- Augmentation and what type, yes or no?
- Within current regulations or outside of current regulations.

- Areas of zoning (i.e., extensive or intensive forest management activities on areas not under owl concern versus active management on a broader scale).
- Placement for optimal dispersal.

Moderator's Workshop Summary

JOHN INNES*

We have had a very intensive couple of days, and I can see from the audience that everyone is tired and wondering whether they will catch that next ferry or flight. Consequently, rather than providing a detailed summary of the workshop, I would like to wind up this workshop now. In doing so, I should say that I am doing so with some rather mixed feelings.

I am **cautiously pleased** that there is evidence that we are dealing with this international problem in an international fashion. I have seen too many maps from the western United States that are simply blank north of the 49th parallel, and B.C. maps treat the area south of the border in the same way. We are now dealing with air quality issues in a trans-border fashion, and conservation issues should be dealt with similarly.

I am **depressed** that the future of Spotted Owls in British Columbia looks like one of extirpation. However, there are many success stories of species being brought back from the edge of extinction, including the Chatham Island Robin, the Né-Né Goose, and the Whooping Crane, and also species that have returned from very low population levels, such as the Peregrine Falcon and in the United Kingdom, the Sparrowhawk.

I find it **exciting** that there are so many tools available to us to plan better. British Columbia leads the world in forest planning models and the presence of so much Crown land enables us to apply these models, when we choose to do so. This provides us with enormous advantages over the United States, where so much land is privately held.

I am **frustrated** and even **annoyed** that we are not devoting sufficient resources to this problem, and that some of those resources that are allocated are being managed so poorly. Despite the Spotted Owl being seen by some groups (such as RENEW) as being a national conservation priority, the Province of British Columbia does not even have an official Spotted Owl specialist. It is particularly annoying that the cost-efficient allocation of scarce resources to solving the problem is being so hindered by the rigid application of accounting rules associated with the financial year-end that it is impossible to plan an effective system of surveys during the pre-breeding and breeding season.

I think that the problem is **challenging** in many ways, but in particular because the socio-economic situation is changing so rapidly. Forest tenures in the area occupied by the Spotted Owl in southern British Columbia are going to be heavily impacted by the redistribution of tenures instigated by the provincial government. This, together with other major policy changes associated with the *Forest and Range Practices Act,* will create both problems and opportunities.

I am left **uncertain**. There have been many questions raised during this workshop and we don't seem to have many of the answers. Clearly, some questions are more important than others, but what are the priorities? What is clear is that we do not need to "re-invent the wheel." Others have looked at some of these problems, and we should be prepared to learn from them. The lack of answers to these questions should not stop action; indeed, the National Accord for the Protection of Species at Risk, which British Columbia has signed, states, "We recognize that…lack of full scientific certainty must not be used as a reason to delay measures to avoid or minimize threats to species at risk."

I am **encouraged** by the spirit of cooperation that seems to have pervaded this workshop. It is good to see government officials, industry specialists, and scientists trying to work out mutually agreeable solutions. However, in British Columbia, we are good at doing this. So I would like to see some follow-up from this workshop, with talk being translated into action, something that we in British Columbia are bad at doing.

I am **nervous** that despite knowledge of what we should be doing, we are not doing it. In particular, we are not applying adaptive management, the ideal approach to forest management when there is scientific uncertainty. There is a lack of emphasis on pre- and post-harvest surveys, so we don't really know if what we are doing is actually effective in achieving our goals.

I am **concerned** at the lack of data and ability of traditional government approaches to deal with the complexity of the situation. Government officials need to break down the barriers between the different ministries (especially between the ministries of Forests, Sustainable Resource Management, and Water, Land and Air Protection). While this may be occurring to some extent at senior levels, this workshop has shown yet again that it is not happening at an operational level.

I am **puzzled** at the potential role of fire suppression. Is this going to be part of the problem or part of the solution? British Columbia is one of the best fire suppressors in the world, but it cannot lay claim to having the best fire management. To what extent should we be using prescribed fire in some areas to reduce the risk of major fires in the fire refuges that Spotted Owls seem to so favour? By suppressing fire, we have increased the risk of major fires that will spread in the few remaining nesting areas.

I am **disappointed** at how few people from First Nations attended this meeting. They are likely to going to be managing a significant proportion of Spotted Owl habitat in the future, and I would have liked to have seen them present.

Finally, I am **delighted** that this workshop has been such a success. This can be directly attributed to the efforts of Liz Williams from the B.C. Ministry of Sustainable Resource Management and the two conservation biologists from FORREX (the Forest Research and Extension Partnership), Kathi Zimmerman and Kym Welstead, ably assisted by a team from FORREX—Shawn Morford, Kathie Swift, Rex Turgano, and Jennifer Turner. They should be congratulated on their efforts.

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APPENDIX A

Workshop Agenda

Wednesday, January 21, 2004

8:30–8:45 **Welcome Address**
Warren Mitchell, B.C. Ministry of Sustainable Resource Management
Kathi Zimmerman, FORREX
Workshop Overview
Moderator: John Innes, University of British Columbia

8:45–9:15 **Requirements and Responsibilities for Species Recovery**
Panel: Rick McKelvey, Environment Canada
Bruce Morgan, B.C. Ministry of Water, Land and Air Protection
Myke Chutter, Recovery Team Chair

9:15–9:45 **Critical Habitat Overview**
Rick McKelvey, Environment Canada

9:45–10:30 **Demographics Overview**
Panel: Joe Buchanan, Washington Department of Fish and Wildlife
Dale Herter, Raedeke Associates, Inc., Washington
Alton Harestad, Simon Fraser University
Keith Simpson, Keystone Wildlife Research Ltd.

10:30-10:45 MORNING BREAK

10:45–11:45 **Habitat Management Overview**
Panel: Joe Buchanan, Washington Department of Fish and Wildlife
Myke Chutter, B.C. Ministry of Water, Land and Air Protection
Gene MacInnes, B.C. Ministry of Forests
Bill Rosenburg, International Forest Products

11:45–12:00 **Moderator's Summary**

12:00–1:00 LUNCH (provided)

1:00–2:00 **Proposed Habitat/Population Model for B.C.**
Glenn Sutherland, Cortex Consultants Inc.

2:00–3:00 **Landscape-Level Habitat Models and Population Models**
Panel: Kevin McKelvey, USDA Forest Service Research Station
Marvin Eng, B.C. Ministry of Forests, Research Branch
Peter Arcese, University of British Columbia
Bruce Blackwell, B.A. Blackwell and Associates Ltd.

3:00–3:15 AFTERNOON BREAK

3:15–4:15 **Stand-Level Habitat Enhancement Models and Practices**
Panel: Paula Swedeen, Washington Department of Fish and Wildlife
Brian D'Anjou, B.C. Ministry of Forests
Bob Gray, R.W. Gray Consulting Ltd.
Doug Ransome, DBR Forestry-Wildlife Integrated Management

4:15–4:30 **Moderator's Summary**

7:30–9:30 **Poster Session and Slide Show: Ecology of Northern Spotted Owls**–*Jared Hobbs*

Thursday, January 22, 2004

8:30–9:00 **Moderator's Overview: Setting the Stage for the Break-out Groups**

9:00–10:15 **Break-out Group Meetings: Refinement of questions to be addressed by model**
Group A: Habitat Management
Group B: Population Ecology
Group C: Habitat Enhancement

10:15–10:30 MORNING BREAK

10:30–11:50 **Presentations by Break-out Groups**

11:50–12:00 **Response by Modellers**

12:00–1:00 LUNCH (provided)

1:00–2:00 **Socio-Economic Analysis and Requirements**
Panel: Rick McKelvey, Environment Canada
Nancy South, B.C. Ministry of Water, Land and Air Protection
Glenn Farenholtz, B.C. Ministry of Sustainable Resource Management

2:00–3:30 **Modeller's Request for Additional Questions re: Habitat and Population**
Management Scenario Development

3:30–3:45 AFTERNOON BREAK

3:45–4:45 **Scenario Development Working Session**

4:45–5:00 **Moderator's Workshop Summary**

Appendix B

Discussions and Questions Recorded During the Presentations

Note: This section includes notes recorded during the presentations and were not discussed by the full forum. Clearly, the views expressed by contributors and participants are their own and are not necessarily those held by the editorial staff, our funding partners, or associated groups.

SESSION 1: WHAT DO WE KNOW? GAPS, UNCERTAINTIES, AND CONSENSUS

Requirements and Responsibilities for the Species Recovery Overview

Current recovery strategy, not yet publicly released:

1. The Spotted Owl was listed as the highest priority for recovery in Canada by RENEW in 2001;
2. Need to consider biological and technical feasibility of recovery;
3. Quick response is needed for this recovery to take place.

Recovery Action Plans being developed for:

1. habitat;
2. population;
3. economics and communication.

Where are the following issues reflected in the existing plan?

1. Data repository and access;
2. Data collection and management plan;
3. Monitoring plan and adaptive management support;
4. Sharing information between British Columbia and the United States.

Critical Habitat Overview

- Do we have the ability to predict length of time needed for critical habitat to be maintained to help the population recover?
- Need to identify all data needs by species (Spotted Owls, Barred Owls, prey species, etc.);
- What are the future needs if the population recovers?

Demographics Overview

- Recent Spotted Owl estimates in British Columbia: some estimate approximately 33 pairs, others estimate 50 pairs; some people suggest fewer.

- Potential limiting factors include:
  - habitat changes, diminished connectivity;
  - West Nile Virus may be a factor;
  - isolation of populations has dispersal implications;
  - competition with Barred Owl: What is the impact?
- Exact bounds of the historical range are somewhat uncertain;
- The natural fragmentation of the B.C. landscape creates a problem of continuous cover;
- A local model needs to assess British Columbia's distinct population and should include differentiation between reproduction and survival habitat classes/requirements.

Knowledge gaps

- There has been limited monitoring near the Canadian border in the United States; we need to know if B.C. owls are genetically distinct from U.S. owls;
- Gaps: exact range of the species, dispersal (juvenile/adult), habitat condition, mortality rates, home range size and habitat use pattern, survival rates, nesting frequency, and how many eggs are laid/hatched/fledged;
- Better understand habitat quality and prey population relationships;
- Better understand competition with Barred Owls;
- Data are scant on causes of differential mortality and productivity rates between dry zones in the eastern Cascades versus wetter areas in the west;
- In Cascades, study found that owls prefer large undisturbed areas of older mature forests with some small openings (openings improve productivity by providing higher levels of prey species); What percentage of area as openings is enough versus too much?
- B.C. owls are at northern limit of species range; linkage to U.S. owls not clearly understood;
- What are the differences between coastal versus interior birds (e.g., food source, nesting frequency/success, territory size, adult survival rates)?
- Do climate extremes in British Columbia have an impact?
- What is the annual range for movement? Specific to territory? Amount of interchange?

Habitat Management Overview

- Safety issues when managing forests for Spotted Owls:
  - Must keep worker safety in mind when considering feasibility;
  - Select tree retention requires hand-falling, which is dangerous;
  - Need flexibility built into plans/guidelines to make decisions on the ground for best retention strategies.

Knowledge gaps

- East slope data are lacking. Are there barriers to movement into this area?
- Joint understanding of habitat on both sides of the border: are spatial gaps identified?
- Better understanding of competition with Barred Owls (scientific effect on home ranges, dispersal, etc.);
- Better understanding of dispersal as it relates to habitat and habitat management; impact of habitat loss versus other factors;
- Better understanding of status and population demographics of owls;
- Threshold where insignificant factors become significant factors—impact? How to mitigate these factors;

- More inventory information of B.C. landbase besides forest cover;
- Better understanding of effectiveness of silviculture practices.

SESSION 2: UNDERSTANDING MODELS, THEIR USES, AND LIMITATIONS

Proposed Habitat/Population Model for British Columbia

What types of questions can be addressed by models?

- Broad strategic elements/test of extremes;
- Habitat quality index;
- Likelihood of recovery;
- Regional habitat contribution;
- Conservation options;
- Change in habitat over time;
- Prey/predator relationships.

Limitations of Models

- Accuracy of data being used (i.e., reliability of forest cover data is a limitation);
- The need to use surrogate data sets (from Washington) is a limitation;
- Data standards and level of data validation—a significant amount of interpreted data has not been ground-truthed;
- Model has a landscape focus (habitat level) that is a more strategic focus; not designed for stand-level risks/trade-offs;
- To predict habitat, we need data on how trees are growing;
- Need more information on sensitivity of Spotted Owls to specific forest management activities (i.e., stand-level activities);
- Model depends on existing inventory and data;
- Need agreement on credibility of model framework and accuracy of the data;
- Need to consider the owl's reality versus our interpretation of their reality.

Landscape-Level Habitat Models and Population Models Panel

Model Limitations and Capabilities

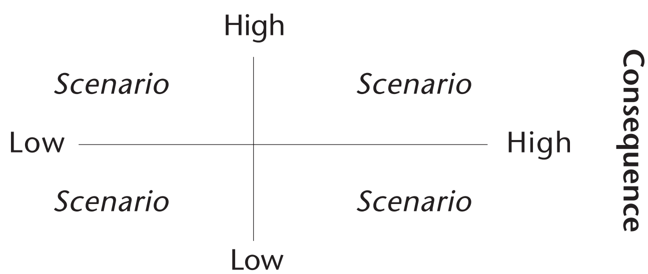
1. Validation of ecological models is not possible;
2. You know that they are not right, but do you know how "wrong" you are?
3. Reliability may be low;
4. Ecological models perform better on relative comparisons versus absolutes;
5. Ecological models are good for testing extremes;
6. Need to assess the reality of the model rules versus the real world;
7. Is the process (loss of owls) already too far down the road for modelling to help?
8. What hidden assumptions are there?

Two kinds of models:

1. Aid in decision-making;
2. Improve understanding.

Risk theory:

Rehabilitation



- Strategic elements that have high risk and high consequences;
- How does the model deal with disturbance, risk, and transparency?
- What is the role of the information/scenario/interpretation of the results?
- What is the role of the decision maker versus stakeholders in the model?
- Are the model development processes and assumptions clearly defined?

Stand-Level Habitat Enhancement Models and Practices Panel

- How much time is required to reach fully functional Spotted Owl habitat from point zero?
- Are Spotted Owls able to re-inhabit entire landscapes that were incapable habitat but have been converted to suitable habitat?
- The TASS model does not grow trees >150 years. How can we do this? We need branch and stem diameter growth;
- What rotation length is appropriate to get desired attributes?
- What is the role of fire as a tool for habitat preparation?
- Forest health/fire impacts on the model: we need to deal with this in today's reality versus natural habitat with species shifts;
- Consequence: For example, Douglas-fir conversion to lodgepole pine is a clue to fuel loading and forest health (Douglas-fir beetle);
- Refugia within natural stands with different fuel loading characteristics influence the prey base (e.g., northern flying squirrel).

Stand-level manipulations (model simulations) to consider:

1. Increase in prey species with increase in ground/understorey vegetation;
2. Increase in coarse woody debris and snags;
3. Spatial heterogeneity.

Management interventions to consider:

1. For example, thinning, crown differentiation, and coarse woody debris retention;
2. Promote height stratification and ground vegetation;
3. Multiple tree species;
4. Variable density thinning;
5. Use thinning in conjunction with longer rotation (e.g., 40-year-old Douglas fir to 140-year rotations);
6. 2- to 10-ha scale (small patches to ¼ to ½ acre cut to mimic spatial heterogeneity);

SESSION 3: REFINING CRITICAL QUESTIONS FOR THE MODEL

No additional notes. See notes in the proceedings.

SESSION 4: SOCIO-ECONOMIC ANALYSIS AND SCENARIO DEVELOPMENT

No additional notes. See notes in the proceedings.