BorNet International

CONFERENCE PROCEEDINGS

BorNet International Conference on
Biodiversity Conservation in Boreal Forests
Uppsala, Sweden • May 27 – 28, 2002

Edited by Susan Leech, Carolyn Whittaker and John Innes

University of British Columbia, Canada

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BorNet International is a network of researchers, forest managers and government representatives developing a synthesis of available information on the conservation of biological diversity and identifying gaps in our understanding in order to further develop coordinated research efforts among boreal countries worldwide.

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The Sustainable Forest Management Network is a national partnership in research and training excellence. Its mission is to deliver an internationally recognized, interdisciplinary program that undertakes relevant university-based research. It will develop networks of researchers, industry, government and First Nations partners, and offer innovative approaches to knowledge transfer. The Network will train scientists and advanced practitioners to meet the challenges of modern natural resource management.

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Contents

Executive summary

IN MAY 2002, BORNET HELD AN INTERNATIONAL WORKSHOP IN UPPSALA, SWEDEN. THE OBJECTIVE of this workshop was to compare international approaches to the following three questions about forest management in boreal forests:

- How much and where should forests be fully protected in reserves?
- How can management effectively restore/recreate/maintain biodiversity?
- How should we monitor the effectiveness of our biodiversity conservation efforts?

The workshop was attended by over 40 participants from eight countries, including all countries with significant amounts of boreal forest.

Within the workshop, there was general agreement that even with an emphasis on retaining habitat elements, current forest management practices in the boreal forest are likely to homogenize areas, reducing the complexity of stands and reducing the variety of microhabitats. To maintain biodiversity across all scales and to provide benchmarks against which to compare different types of management, we need large, intact, natural protected areas. There was a feeling that high conservation values should be maintained across the international boreal. A synthesis and pan-boreal gap analysis regarding how much is currently protected, levels of protection and what gaps there are in the network of reserves is required. An approach similar to that used by the European Union BEAR project would be useful, with an emphasis on a common classification system. There is a critical industry need (for wood-users such as IKEA) for access to information about where wood is being sourced. Industry requires a method for assessing whether wood is coming from High Conservation Value Forests (HCVFs). It is evident that some countries have more HCVFs simply because of their short history of forest management; work needs to be done to address the need to treat countries equitably across the boreal. Europe must focus on restoring HCVFs, while Canada and Russia must work to avoid losing HCVFs. The workshop proposed that research should be focused on currently intact forests or restoring intact forests so that there is ecological representation and equitable distribution of protected areas across the boreal.

There is no clear answer to the question: How much is enough? Workshop participants agreed that this question is impossible to answer without a clear statement of goals, but even assuming that the goals of forest management are clearly stated, we still have insufficient information to answer this question. Eventually, a well-designed monitoring program could provide an answer. Thresholds are important because they provide forest managers and policy-makers with a target which can then be assessed over time and adjusted as required. There is a need to put more effort into defining thresholds of habitat loss for different species, with a particular focus on the species most sensitive to forest harvesting. Thresholds are an important means to communicate and effect change on the ground.

There is currently a good understanding of stand-level concerns regarding the maintenance of key habitat elements (e.g., snags, coarse woody debris); a lot is known about methods for maintaining/restoring biodiversity. Scale is key, as there are gaps in our fine-scale knowledge of groups such as lichens, fungi, insects and the processes related to this scale of organism, as well as gaps in the landscape-scale biodiversity factors. We have limited knowledge regarding some landscape-level questions (e.g., the effectiveness of corridors and connectivity between intact forests). There was some discussion

about using natural disturbance as a template, but a zoning approach may be more appropriate in areas with extensive management history and with land tenure constraints. We also need more information about the relative effectiveness of different methods for restoring/maintaining biodiversity.

A multi-metric index will not be sensitive enough to warn us of rare/endangered species loss before it occurs. Several studies have shown that indicators do not correlate well with one another. The correlations are so weak that it would be hard to use them as an index. We need a more sensitive measure as an early warning system; however, collecting data for this purpose will be very expensive. We need an indicator system that looks after all species. Current assessment programs are biased against rare species; we should try to incorporate these in a cost-effective way. On a coarse scale, indicators (e.g., of amount of dead wood) are useful. In summary, by looking at a comparison of different disturbances or human footprints (e.g., from Europe to Russia to Canada), we could study how variation in disturbance correlates to different indicators.

The circumpolar twinflower symbolizes the need to consider the boreal from a global perspective. JOHN INNES PHOTO

Workshop goals and structure

This document summarizes the presentations and ensuing discussions from the first international BorNet workshop, held in May 2002 in Uppsala, Sweden. The goal of this workshop was to synthesize information and identify knowledge gaps around three key thematic areas related to biodiversity conservation in boreal forests, as identified by the BorNet steering committee. These areas are:

How much and where should forests be fully protected in reserves?

How can management effectively restore/recreate/maintain biodiversity?

How should we monitor the effectiveness of our biodiversity conservation efforts?

To accomplish this goal, the two-day workshop was divided into four sessions. The plenary session set the global context for our discussions, providing participants with the perspectives of industry and policymakers around the issue of biodiversity conservation in boreal forests. The three subsequent sessions focused on each thematic area, providing opportunities for focused discussions around synthesis opportunities and knowledge gaps for each question. Within each session, invited speakers identified what they felt that we know about each thematic area. Following these presentations, expert panels were invited to give brief statements to define some of the challenges around each question. Finally, break-out groups following each panel presentation were charged with the task of developing research questions to fill knowledge gaps.

Overview of proceedings and next steps for BorNet

These proceedings summarize presentations made in each session, including key points and subsequent discussions. At the end of sessions two, three and four, a summary of information synthesis ideas and knowledge gaps around each thematic area is provided in a table format. These summary tables include information raised during presentations, the panel sessions, and the break-out groups. A detailed summary of discussions in break-out groups is provided in Appendix 1.

As a result of this workshop, two expressions of interest have been presented to the European Union 6th Framework around the effects of different forest management practices on biodiversity conservation around the boreal. Both projects focus on using the gradient of forest management conditions to establish research sites that will investigate many facets of biodiversity conservation, including habitat thresholds. If accepted, these research projects will represent a significant move towards international cooperation on biodiversity conservation across boreal forests.

In addition to these research proposals, the summary tables of synthesis ideas and knowledge gaps around each thematic area will be used at a workshop in November 2002 to determine how BorNet should prioritise these items into a funding proposal for Phase Three of the project. Following this workshop, BorNet will outline how it will progress with information synthesis and dissemination to policy-makers, practitioners and researchers around the boreal.

1.1 IKEA purchasing strategy

Hans Djurberg, IKEA North America, Toronto, Canada

ABSTRACT: IKEA believes wood is an excellent resource; it is renewable, recyclable and biodegradable. However, IKEA recognizes that knowing where wood comes from is critical. Like many companies, it is responding to consumer demand that wood products be sourced from well-managed forests. IKEA, which has 500 suppliers working with wood procurement, has developed the "staircase model," a set of forest management standards arranged in four levels. The principle behind this model is that solid wood suppliers must meet certain minimum standards, and must work towards improving their practices by gradually working through the steps of the staircase model. Over the long term, IKEA would like to have all wood sourced from verified well-managed forests; i.e., forests that have been certified according to a forest management standard recognized by IKEA.

The staircase model

Level 1. Wood cannot be sourced from Intact Natural Forests (INFs) or High Conservation Value Forests (HCVFs), unless the Forest Stewardship Council (FSC) has certified these operations. INFs are identified using information from Global Forest Watch. IKEA is developing a toolkit to help wood suppliers identify HCVFs (see the following presentation by Steve Jennings).

Level 2. Sourced wood must have a known origin, tropical species must be FSC certified, and wood cannot be sourced from plantations that have replaced INF from 1994 onward. IKEA conducts supply-chain audits to ensure wood has a known origin.

Level 3. Called 4Wood, the purpose of this level of the IKEA standard is to promote a transition of forest management from the minimum demands at level 2 towards the level 4 standard; it is applicable particularly to forests that are certified to other standards. These standards are compared to 4Wood and, if they are found equivalent, are referred to as "4Wood equivalent."

Level 4. Wood comes from "well-managed forests" – i.e., those that meet an official standard that includes established performance levels cooperatively developed by a balanced group of environmental, economic and social stakeholders and verified by an independent third party. The only standard currently recognized by IKEA is FSC.

Information needs

To source wood from appropriate suppliers as described above, and to apply these rules in a fair and consistent manner, IKEA needs access to *objective information* on the status of forests and wood suppliers. Global datasets on conservation and other values are a key industry need.

DJURBERG: KEY MESSAGES

- IKEA has developed a framework called the staircase model to guide its acquisition of wood from well-managed forests.
- Together with ProForest, IKEA is developing a toolkit to help wood suppliers identify HCVFs.
- IKEA requires objective and accessible information on high conservation values in the boreal forest to support its purchasing decisions.

1.2 The High Conservation Value Forest toolkit

Steven Jennings, ProForest, United Kingdom

Abstract High Conservation Value Forests (HCVFs) are those forests that contain exceptional biological, environmental or social values. HCVFs were first defined by the Forest Stewardship Council (FSC), forming Principle 9 of the FSC Principles and Criteria. There has since been great interest in applying the concept to forest management, timber procurement and land-use planning. This rapid uptake reflects the elegance of the idea, which focuses on first identifying important or critical values, and then managing forests in such a way as to maintain or enhance these values. However, to date, forest stakeholders have been given little guidance on how to identify or define HCVFs. ProForest is coordinating the development of a global HCVF toolkit to provide guidance and harmonization to the process of identifying HCVFs. This project is funded by the WWF/IKEA forest partnership. ProForest is a consultancy company that specializes in making forest policy practical; it deals particularly with forest certification issues.

What are HCVs and HCVFs?

All forests contain biological, environmental or social values, but we generally agree that some contain more of these values than others. FSC developed a concept for forests where these values are outstanding or critical. The concept works by identifying high conservation values and managing the forest to maintain or enhance those values. The advantage of identifying forests in this manner is that it avoids debate on definitions such as "natural," "primary" or "industrial logging." The identification of HCVFs is a key area in which NGOs, the forest industry and scientists can and are working together.

The toolkit

What is it?

A practical guide to assist stakeholders in identifying and managing HCVs and HCVFs for FSC certification and other initiatives.

The toolkit defines key HCVF in terms of biodiversity values (HCV1, 2 and 3), ecosystem services (HCV4) and social and cultural values (HCV5 and 6).

Who is it for?

Forest managers, certification auditors, national standards writers, purchasers and others.

JENNINGS: KEY MESSAGES

- Identifying and managing HCVFs is increasingly important for responsible forest management, timber purchasing and land-use planning.
- A toolkit is being developed to provide guidance for identifying and managing HCVFs, and to harmonize international approaches to identifying HCVFs.
- One of the strengths of the HCVF concept is that it is inclusive – it incorporates existing scientific and social data and knowledge, which can then be used to improve forest stewardship.

The assessment process

1. Preliminary assessment of the forest area eliminates forests that are clearly not HCVFs. This process requires global datasets and access to objective information. Examples of assessment categories include: protected areas under current or future local/regional or national legislation or designated by an international authority; forests containing rare species; forests containing endemic species; and forests containing critical migration or breeding sites.
2. Forests not eliminated through the preliminary assessment are subjected to the full assessment, which is more detailed and requires significant expertise. This assessment identifies values according to assessment categories; if they are present, they must be managed for. For example, detailed questions for *1.2 Rare species* include:
    - Clarifying what is there;
    - Highlighting important ecological processes; and
    - Identifying extraordinary evolutionary processes.

Grey jay, a typical bird of the Canadian boreal forest. JOHN INNES PHOTO

1.3 Keynote address

Ola Ullsten, Co-Chair of the World Commission on Forest and Sustainable Development, former Ambassador from Sweden to Canada and Italy, Canada

ABSTRACT: We need to look at forestry from a global perspective, to really see where there are needs around achieving sustainable forest management. Initially, sustainability was used synonymously with "sustained yield" and the emphasis was placed on increasing the yield of our forests. As a result, Sweden, for example, has 65 per cent more volume in forests than it did at the turn of the century. We now need to think outside the forests and look at forest management within a broader context. In particular, the looming spectre of climate change will put huge pressures on our forests. Some estimates say we may lose 50 per cent of the boreal forest due to climate change, and that this change will proceed too quickly for adaptation of boreal species. Maintaining forests and forest cover is key to buffering the effects of climate change.

Coping with climate change: UN recommendations related to forestry

1. We need to focus on *reforestation*. This program will be important as a carbon sink, to provide an energy source, and to help meet future wood supply demands.
2. We need to establish reserves and conserve biodiversity hotspots (to fulfil the need for biodiversity conservation).
3. We should make more use of plantations to relieve pressures on HCVFs.

Related to the last point, only 3 per cent of the world's forests are plantations, yet these plantations produce 22 per cent of the world's forest product needs.

Canadian perspective: the Forest 2020 program

This program is built on two key principles.

1. The need to meet demands from the environmental movement to stop logging in pristine forests. This need is key: 80 per cent of logging in Canada occurs in pristine forest.
2. The need to compete with wood products from South America and New Zealand. There is a need to begin intensive management in Canada, by establishing plantations containing fast growing species.

Ecological economics

"Real economic growth doesn't rely on capital borrowed from future

Traditionally, people have viewed ecology and economy as two separate issues. However, economy relies on ecology and vice versa. Politicians need to understand and hold this view. Without a healthy environment, economic growth is not sustainable and is borrowed capital from future generations. There is no point in making a distinction between what is good for nature and what is good for people: these are one and the same. Although setting targets for wood harvest is important, the concept of sustainability implies that ecological concerns set limits for economic activities.

Measuring our impact: The Forest Capital Index

We know that the planet has lost approximately 40 per cent of its original forested landscape (WCFSD report, 1999). We have a financial capital index (the gross domestic product) that tells us on a coarse scale how a country is doing economically. However, we have no way of measuring the ecological performance of different countries. We need:

- Information about how forest use through time has changed from natural to intensive management;
- Information about how forest use is affecting the health of ecosystems; and
- Crisis signals and policy guides to achieve sustainability.

Many agencies now monitor the incremental gain or loss of forests, and publish periodic measures of the world's forest cover. There is currently no quantitative measure of the biophysical integrity of forests and their contribution to local and global environmental stability, and therefore to human well-being and security. A Forest Capital Index would provide a single numeric measure comprised of sub-indices and indicators that will introduce a measure of the quality and quantity of forests, in terms of their biotic wealth and their contribution to a range of other ecological, socioeconomic and cultural functions. The Forest Capital Index proposed by the World Commission on Forests and Sustainable Development in its 1999 report builds on initiatives such as the Earth Summit, the Helsinki and Montreal Processes, and forest certification, and would cap the process of creating information policy tools for sustainable use and conservation of forest resources.

The FCI will be developed through the following process (as agreed through an international development meeting held in Guelph, Canada in January 2002):

1. Using existing data and satellite images, select a limited number of indicators on forest ecosystem functions;
2. Aggregate indicators into a Forest Capital Index, to be regularly updated to permit evaluation of progress or lack thereof in sustaining ecosystem functions provided by forests as related to ecological and socioeconomic factors;
3. Identify data gaps in creating reliable indicators;
4. Assess changes over time in the sustainable use of forest resources, focusing on forest ecosystem conditions measured against benchmarks and policy targets;
5. Ensure that the FCI has the potential of being linked to existing and future indices for sustainable development at the national and international level;
6. Test FCI through pilot studies in different countries with different forest types using the same protocol; and
7. Make a separate study on the need to gather, maintain and update data over time.

ULLSTEN: KEY MESSAGES

- We need access to data to create an objective Forest Capital Index.
- Research should focus on testing indicators (to fill data gaps).
- We need benchmarks against which to measure forest ecosystem conditions.
- Information management systems are required to keep the FCI complete and up to date.

1.4 Canadian boreal forest biodiversity research: A synthesis and gap analysis

Carolyn Whittaker, BorNet Coordinator

Authors: John Innes and Carolyn Whittaker, BorNet Canada,
University of British Columbia, Canada

ABSTRACT: The BorNet Canada project was initiated with a grant from the Sustainable Forest Management Network in 2001. The objective was to assess the current context for boreal biodiversity research across Canada and identify gaps in our knowledge. Another task for BorNet Canada was to develop an international network of boreal researchers, resource managers and NGOs focused on biodiversity conservation.

Compiling information from across Canada has been challenging. We have developed an annotated bibliography and draft synthesis paper based on peer-reviewed publications and regional workshops. Proceedings from regional workshops include summaries of discussions; these are available from the BorNet website or the Sustainable Forest Management Network at the University of Alberta. These regional workshops have led us to conclude that there are knowledge gaps in habitat requirements of individual species and taxa, as well as gaps in our understanding of habitat requirements over different spatial scales.

Within the regional workshops, many of our discussions revolved around selecting indicator species and focusing on habitat specialists. Literature illustrates that habitat specialists are not necessarily negatively impacted by forestry; some open-habitat bird and mammal species benefit from early post-harvest habitat. To develop indicator species sensitive to loss of habitat, it would be most useful to identify the types of habitats that are being lost or converted and then focus on the species associated with those habitats. Indicator species must indicate changes in the quality of the habitat, and those species selected should be sensitive to forest harvesting.

Discussions in Canada revealed that we often do not test the assumptions made in assessing biodiversity impacts. Results of many studies on individual species have limited applicability due to regional, biological and ecological variation in habitat needs. The assessment of the biodiversity implications of forest management need to be assessed across a range of spatio-temporal scales, but we must first test our assumptions and combine information regarding generalists with that regarding specialists. Small-scale studies, including those on invertebrates, need to be balanced with large-scale studies of habitat. Finally, we must be aware of the confounding aspect of the temporal scale, as trends in recent years must be placed within the continuum of large timeframes with an emphasis on the rate of change. The spatial scale of conversion may not be as significant as the rate at which the boreal is being harvested. Although there have been few documented species extinctions due to forest harvesting, it is important to remember that we may be building an "extinction debt" in the boreal. We have not adequately assessed how the current rate of access and conversion of intact forest to managed forest may affect species extinctions in the future.

WHITTAKER: KEY MESSAGES

- We must identify the habitat types at risk from forest harvesting and then identify indicator species that are dependent on these habitat types and sensitive to change.
- We must assess our current forestry practices in the boreal within the context of the potential extinction debt we are incurring.
- We must be prepared to test the many assumptions that we have about biodiversity in boreal forests.

2.1 Inventory of intact natural forest landscapes in northern European Russia

Alexey Yarshenko, Greenpeace, Russia

Authors: A. Yu. Yaroshenko, P.V. Potapov, and S.A. Turubanova, Greenpeace Russia

ABSTRACT: Work on identification and mapping of intact forest landscapes in northern European Russia has been conducted by the GIS laboratory of Greenpeace Russia (together with other organizations within the framework of Global Forest Watch Russia). The objective was to identify remaining large areas with a minimum of human disturbance (for the purpose of developing regional conservation strategies). The smallest areas considered were at least 50,000 hectares and at least 10 kilometres wide. This size allows most of the natural structure and dynamics of the natural landscape to be preserved and reduces edge effects to a minimum.

The inventory used many sources and types of information to make it as exact and credible as possible. This approach involved a step-by-step elimination of different types of disturbed areas from the studied territory, including:

- Basic infrastructure (cities and villages, main roads) – using general topographical maps;
- Tundra and severely disturbed areas – using satellite images from Resurs MSU-SK (resolution 150 m/pixel); and
- Other disturbances, including small and low-intensity disturbances – using satellite images from LandsatETM+ and, for smaller areas, also Resurs MSU-E and SPOT HVR (15-35 m/pixel).

Some forms of human disturbances (associated with ancient primitive forms of economic activity like grazing, cleaning of hay fields along small streams, hunting, production of fuelwood, or "low impact" human disturbances such as pine resin collection) were considered insignificant (i.e.,, as "background disturbance").

The map was verified using field data from 67 key inventory areas. The final boundaries were drawn on the basis of imagery from Landsat ETM+ and other imagery of similar resolution.

Intact forest landscapes make up about 13 per cent of the forest zone of European Russia. Most of this consists of remote, inaccessible, low-productivity ar-

YAROSHENKO: KEY MESSAGES

- How much is enough might not be the appropriate question in Russia, because harvesting is proceeding at such a rapid rate that action is needed now.
- Foresters have no mechanism to inform policy on inappropriate rules.
- There is a need to understand the barriers in Russia to sustainable forest management.

eas in the far north and near the tundra, mostly with a site productivity less than 1m^3/ha and year and a stocking in mature stands of less than 100 m^3/ha. About 52 per cent of the intact landscapes are in the transition zone between forest and tundra and officially excluded from industrial logging. The biggest threats to intact forest landscapes are logging and mineral exploration. The most northern parts are typically situated beyond the reach of economic activity.

Discussion

A brief overview of forest management in Russia was requested.

Formerly, all of the forest belonged to the state, but now there are some private forests called timber lands (estates). All forests are managed under the Ministry of Natural Resources. Companies can access timber through different kinds of licenses. There are short-term concessions that are awarded for two to five years, and long-term licenses that are awarded through a competition for up to 49 years. All cutblocks require logging tickets. To get logging tickets, companies must apply to the state enterprise with plans.

Russia has a forestry code and logging rules, which are usually inter-regional. Russia has very strict logging standards, but, "the strictness of Russian legislation is compensated by the lack of necessity to fulfil it."

The annual harvest in Russia is approximately 120 million m^3, about half of which goes to foreign markets.

Scots pine forest with ground layer dominated by Cladonia lichens. Kola Peninsula, Russia. JOHN INNES PHOTO

2.2 Detection of thresholds in forest bird species' response to silvicultural intensity in the Acadian forest of eastern Canada

Marc-André Villard, Canada Research Chair in Landscape Conservation at the University of Moncton, New Brunswick, Canada

Authors: M.-A. Villard and J.-S. Guénette, Department of Biological Sciences, University of Moncton

ABSTRACT: Intensive forest harvesting and silviculture have only recently become dominant in the boreal forest of Canada. However, at the southern edge of the boreal zone, in the Acadian forest, large-scale industrial forestry has been taking place for over 50 years. In fact, this forest region has some of the most intensive forestry in Canada. The Acadian forest region is characterized by a mosaic of conifer stands (*Picea* spp., *Abies balsamea*), with shade-tolerant deciduous species (mainly *Acer* and *Fagus*) on well-drained sites. The main agents of natural disturbance are insect outbreaks (spruce budworm) and windthrow. The main silvicultural treatments applied are clearcutting followed by conifer (*Picea*) plantation and herbicide treatment. Second or third-growth deciduous stands are being treated under various uneven-aged management schemes. The presence of sizable naturally-regenerated stands has, thus far, allowed the maintenance of a level of regional biodiversity that is comparable with that of less intensively-managed regions, at least for vertebrates. However, these stands are rapidly being treated. In this talk, we (1) present an approach to detect thresholds in the response of target species to silvicultural intensity at the stand and landscape scales; (2) apply this approach to a data set of 326 stations representing a gradient in silvicultural intensity; (3) examine the response of 23 species associated with mature stands to this gradient; and (4) use observed threshold values to propose a mobile (floating) reserve design. The empirical approach we propose should be applicable to other regions of boreal forest with similar natural disturbance regimes.

VILLARD: KEY MESSAGES

- Defining thresholds of habitat alteration beyond which different species cannot persist is a key tool for guiding forest management practices on both the stand and landscape levels.
- Threshold curves for species persistence against harvesting intensity are much more shallow and gradual than species extinctions due to habitat loss.
- If we set thresholds for habitat alteration in certain habitat types for most sensitive bird species studied, will this also take care of less mobile species (e.g., lichens, beetles)?
- What can serve as an adequate benchmark if no ecosystem is left untouched? How do you know if an ecosystem has integrity?
- Should reserve systems be fixed or mobile? Within areas actively managed for timber, mobile reserve systems which keep a target level of old growth forest within an area are much more palatable to the forest industry. However, we do not know if mobile systems can adequately protect less mobile species.
- We need to continue defining thresholds for sensitive species, and use them to determine how much and where forests should be protected.

Discussion

1. *What is the experimental hypothesis?* We expected species to respond in a particular way, depending on their habitat needs. Most species are still present, and this makes sense because you would expect them to tolerate a certain amount of habitat alteration. However, there is a range beyond which we are going too far for some species, e.g., a species that nests or forages in the canopy.
2. *What is the biological explanation behind thresholds?* Thresholds probably occur where the intensity of harvesting has a significant effect on energetics. For example, pileated woodpeckers forage and nest in large-diameter trees. When the density of these trees gets too low, it takes too long to move among suitable foraging substrates (large trees), so it is not energetically profitable to nest in these areas.
3. This part of Canada is dramatically altered, which raises a point that we need to discuss. How do you bridge the gap between this kind of study and the fact that when you get dramatic changes in the ecosystem, species are going to disappear?
4. It would be interesting to do a comparison study between areas with dramatically different management histories, with parts of Canada and Russia being relatively "unspoiled" and Fennoscandia being altered. We have some comparative information on carabid beetles, looking at spatial comparisons between Canada and Finland. These studies show that carabid beetles have much higher diversity in Canada, with more original species communities retained. Habitat in Finland is much more homogenous, and this seems to be reflected in carabid beetle communities as well.
5. *How do you measure the health of an ecosystem if there is no untouched ecosystem left? What is an ecosystem and how do you know if it has integrity?* There is virtually no old growth left in New Brunswick. We can use information from historical records to approximate what we would expect to find there. In our study, we used "integrity" as a gradient – we have no ecosystem as "integral" as old growth, but we still have many of the facets and habitat elements.
6. *Has anyone used individually based models to look at how birds respond to silviculture treatments? And what about different groups of birds?* I do not know of many attempts to model at an individual scale for forest songbirds, but perhaps BACHMAP does. This approach is applicable to other birds. Woodpeckers were included in this list, and we will start applying it to raptors, which are probably a lot more sensitive to changes on the landscape.
7. *New Brunswick has been altered by logging, but no species have been lost. Can you explain this?* No species have been lost amongst the higher vertebrates (except wolves and woodland caribou). If you looked at invertebrate species, you would probably see some species lost. For most species, we just do not know what the historical distributions were. The first Maritime bird analysis was only completed in 1992, so we don't have the data.

There is a definite change in community types. A particular type of forest community that used to be there is gone – so that's an important alteration in vegetation communities.

Should reserve systems be mobile or fixed? New Brunswick has proposed a mobile reserve system to protect older forests. This system basically requires forest companies to ensure that there are stands fitting the definition of "old forests" within a unit, but these old forests do not need to be located at the same place all the time. This system is a lot more palatable to the forest industry, but we do not know whether it will protect less mobile species.

2.3 How much habitat is enough? Towards a scientific basis for setting boreal forest conservation targets

Per Angelstam, Department of Conservation Biology at the Swedish University of Agricultural Sciences, WWF and Department of Natural Sciences at Örebro University, Sweden

ABSTRACT: The sustainable use of natural resources such as forests is an act of balance. If one or more of the economic, social or environmental components cannot be satisfied, then the use is not sustainable. Therefore the performance of each component should be measured and compared with a target that ensures that the component is maintained long-term. If the environmental sustainability component is interpreted as the maintenance of biodiversity, we can actually begin to formulate such quantitative targets.

The European boreal forest, extending from Scotland to the Ural Mountains, provides a unique resource for the gradual development of sustainable forest ecosystem management. The reason is the steep gradient in land use history whereby the gradual exploitation and intensive management of boreal forest resources has spread like a tidal wave from areas of high demand to more and more remote regions. This "time machine" allows us to understand the effects of the human footprint on the boreal environment, and explore the relationships between habitat measurements and other components of biodiversity.

The work is centred on the following issues. (1). Understand the human footprint on the environment by studying the historic development of habitat change and loss among landscapes/regions. (2). Stratify the boreal forest into different types of dynamics so that nature conservation targets can be set with a habitat resolution that matches the evolutionary past of species. (3). Find species/guilds/groups of species with life-history traits that have adapted to the different forest types, and which can be used as response variables in quantitative analyses. (4). Analyse habitat loss relationships of species in different land use history gradients. (5) Enhance communication between science and practice by establishing practical case studies in different forest history gradients.

ANGELSTAM: KEY MESSAGES

- There is a research need for better indices of impacts on species that are more related to species fitness (i.e., moving away from presence/absence indicators).
- There is still a research need for basic biology about species and their habitat needs, to help understand and define habitat thresholds for species.
- To communicate with forest managers, we need to summarize research in a more accessible format.

Discussion

To complete the work outlined above, we need:

- An approach that looks at the whole range of ecosystem impacts;
- Response variables that are more related to species fitness – i.e., moving away from presence/absence indices;
- More information about basic biology, habitat requirements of specialized species, especially as they vary across different ecosystems; and
- More information about thresholds across spatial scales.

Information needs to be synthesized in an appropriate fashion for managers. Principle component analyses are correct, but difficult for managers to interpret.

2.4 Managing risk to arthropod populations with unharvested reserves

John Spence, Department of Renewable Resources, University of Alberta

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ABSTRACT: Insects and their arthropod relatives are the most diverse multicellular organisms found in boreal forests. Furthermore, their relationships with other organisms that may be sensitive to forestry practices, especially the fungi, make them central elements in ecological processes that structure forests and underpin forest productivity. Arthropod taxa are the ultimate habitat specialists, depending on fine-grained features of the forest about which humans are frequently insensitive or unaware. Rare species, which constitute up to 40 per cent of many arthropod faunal surveys, likely reflect the abundance of habitat relative to sampling effort. This has implications for both monitoring biodiversity and the requirement to leave parcels of unharvested habitat within a harvested landscape. Such parcels must be large enough to sustain specialist faunal elements that depend on rare habitats included, by chance, within them because our knowledge of arthropod habitat requirements is generally insufficient to do this by design. Arthropod assemblages vary regionally and an understanding of this variation may dictate regionally variable approaches to leaving and linking habitat reserves. Even with new efforts to diversify what forestry leaves behind in the wake of harvest, it is likely that harvesting will still homogenize large areas to some extent over a history of forest rotations by eliminating or severely reducing the abundance of rare habitats. Our present limits of understanding make it impossible to manage this risk by design, and thus leaving unharvested islands of sufficient size to act as biodiversity refuges is desirable. Information about changes in the abundance of rare species could be the first evidence about whether this strategy is working, but there are serious challenges in developing monitoring programs that deal with these taxa effectively. Fennoscandian efforts and experience in re-establishing adequate amounts of old forest and provide connections should provide both motivation and direction for deciding how much needs to be left behind as pristine forests are harvested in Canada.

Research questions that need to be addressed

- Size range for reserves: What size is big enough to hold most threatened species?
- Factors critical in location of reserves: What range of features should be represented?
- Appropriate distance between reserves: How far can threatened species move? Is there a risk of genetic losses?
- Importance of corridors: How effective are corridors, and what should they look like?

SPENCE: KEY MESSAGES

- Forest invertebrates may be the ideal indicator of forest disturbance by humans.
- Forestry tends to homogenize the invertebrate fauna.
- We need large, natural reserves left as reference areas, to inform us within an adaptive management framework as to the success of our conservation efforts within managed stands and landscapes.

Discussion

It is important to realize that there is a lot of variation within and between fire disturbances, and that we cannot equate harvesting disturbance with fire disturbance. In terms of invertebrate communities, we see huge differences in harvest and fire origin stands. Eventually (over 30 years), the communities become more similar, but some species are simply missing from harvest origin stands.

2.6 Rachel F. Holt, Veridian Ecological Research Ltd., WWF Canada, British Columbia, Canada

Some questions need answering before you can contemplate how much forest should be protected in reserved (*and some challenges in italics)*.

What is the ultimate goal for the landscape? Is it the maintenance of ecological integrity? *Does everyone involved in the process think these words mean the same thing? What does it mean?*

What certainty is there that the goal will be achieved or is even required? *Is it possible to model alternative scenarios and present outcomes in terms of risk or probability of achieving the goal?*

What is an appropriate scale to answer this question? *Fully protected elements are required at all scales: global (e.g., all of B.C. is likely a High Conservation Value Forest as defined by the Forest Stewardship Council); regional (e.g., ancient forest stands); and stand level (e.g., we need fully protected "full cycle" attributes to create legacies).*

So, how many indicators and thresholds are appropriate? And at what scale should they function? *A local example identified 100+ potential species, and now has 30 indicator species. Given that indicators require thresholds and monitoring, is this approach feasible, appropriate, and manageable?*

Are coarse-filter indicators appropriate? *Emulation of natural disturbance patterns, rates and processes provides a basis for answering the question of "where and how much?" at multiple scales. Technical issues are often thrown up as challenges (can you describe the range of natural variability adequately to employ this concept?) but, particularly in "relatively natural" ecosystems, they provide a useful ecological benchmark from which to assess risks. This approach works well for abundance, but not necessarily for pattern … what are the alternatives? What are the challenges to determining these risks, and what application does this approach have where human/harvesting history is extensive?*

Representation analyses. *Often "representation" is used generically to ask whether a particular feature is present, but it has rarely been used in the context of how much of it would be expected under natural disturbances (e.g., WWF representation analysis; B.C. Protected Areas Analysis).*

How appropriate is it (scientifically) to trade off current versus future protection? *Harvesting history is not random – often the best sites in central locations have been harvested already. If protection focuses on "untouched/intact" forests, what is being missed? How can science and public perceptions be meshed?*

2.7 Jean Paul Gladu, Aboriginal Forest Research Coordinator, National Aboriginal Forestry Association and Sustainable Forest Management Network, Ontario, Canada

From an Aboriginal perspective, all forests and the dynamic ecosystems to which Aboriginal people traditionally belong should be protected. The question could be turned around to ask: What forest areas are suitable for industrial development and activity? With this statement in mind, determining the amount of forests to be developed would be dependent on the area required to continue the relationship that has evolved since time immemorial between Aboriginal people and the land. Forest areas that are integral to the survival of Aboriginal people, such as spiritual and ceremonial sites, hunting, fishing and trapping grounds as well as gathering sites for culinary and medicinal uses, need to be outside the scope of industrial development. The next step in determining how much and where these forests are to be fully protected will be to engage Aboriginal communities through close and sincere interaction with full consideration of their constitutional rights and respect of their traditional ecological knowledge.

2.8 Daryll Hebert, Encompass Strategic Resources Limited, Alberta, Canada

Challenges, strengths and gaps

The main challenge to conserving biodiversity is the logical change from the sustained yield, fibre production paradigm to the sustainable forest management paradigm. Every forest management system has a set of outcomes that supports biodiversity to one degree or another. The change should include a systems approach where testing of the treatment can lead to adjustment of one or more scalar attributes.

In general, there are specific scalar attributes that are part of every management system. These include disturbance type and rate, forest level components such as seral stage, species composition, and representation, landscape pattern and patch size frequency, and a host of stand/structural components. The assessment and integration across scales of these components and habitat elements is paramount for the successful conservation of biodiversity.

Currently, the adversarial process leads to a combination of constraints, at various scales, that have not been tested for ecological benefits nor for economic impacts. At present, it is unclear whether these constraints are enough or too much, since thresholds have not been identified. Similarly, natural disturbance baselines have not been adequately described and incorporated into the forest management system approach. Within a multiscale forest management system, both temporal and spatial representation must be addressed.

In Canada, the current boreal forest matrix (Timber Harvesting Land Base – THLB) has 50 to 90 years of harvest remaining. The harvest rate is proceeding at about 0.4 per cent yr^{-1} in addition to a natural disturbance rate (fire, insects, disease) of about 0.5 per cent yr^{-1}. Thus, there are opportunities to address multiscale issues, identify landscape experiments, and use models, indicators/monitoring programs to address scenarios and outcomes. As the matrix declines (natural forest – first rotation), biodiversity will be supported by our progress in developing multiscale, sustainable forest management systems. Thus, the non-harvest land base (NHLB), protected areas and ecological prescriptions (habitat elements, seral stage) will become the main support for biodiversity. The spatial-temporal representation of the remaining "amount" may also be significant.

A sustainable forest management system must be assessed and adjusted using trade-off modelling within each leg (ecological, economic and social), but most importantly, among legs. The ecological, multiscale requirements/benefits have been poorly described, in the face of measurable, significant, economic impacts.

2.9 Stig Larsson, Department of Entomology, Swedish University of Agricultural Sciences, Sweden

The need for fully protected reserves in the boreal forest, and the quality and size of the reserves, depends to a great extent on the quality of the matrix, i.e., the degree to which reserves are isolated. When assessing the balance between reserves and matrix it is necessary to determine whether the target organism(s) has a positive reproduction rate. In other words, it is essential to know that the biodiversity-managed forest under study is not acting as a sink, where organisms from nearby richer environments emigrate and fail to establish. Because species most likely respond in an individualistic manner to habitat loss and fragmentation, recommendations about planning reserves in the managed boreal landscape should take into account variation in life histories among species, e.g., dispersal capacity, generation time, and resource use. With regard to management it is essential that biodiversity be defined operationally and that relevant response variables are chosen and refined. We must move beyond simply counting species numbers. If the aim of biodiversity management is to minimize risks of local extinction, then concepts and techniques that are applicable for threatened, or near-threatened, species should be developed.

SESSION II: SUMMARY OF COMMENTS AND DISCUSSION "HOW MUCH AND WHERE SHOULD FORESTS BE FULLY PROTECTED IN RESERVES?"

THE BREAK-OUT GROUPS AND SUBSEQUENT DISCUSSIONS IDENTIFIED A NUMBER OF POSSIBLE synthesis projects and research opportunities associated with the question of "how much and where should forests be fully protected in reserves." These are summarized in the section below, along with others identified through the presentations and discussions that followed each presentation. Results from each break-out group are summarized in Appendix 1 at the end of this document. A remaining task for BorNet is to prioritise these research and synthesis possibilities into a list of projects that may be accomplished in the final phase of BorNet.

What we know

- Research shows that forest management is likely to homogenize areas, even with emphasis on retaining habitat elements. Unharvested forests have much more microhabitat variation, which is critical for invertebrate diversity.
- We need large, intact, natural protected areas to serve as benchmarks.

Knowledge gaps and research needs
How big do reserves need to be to capture all diversity?
How well are reserves working?
How can we use traditional ecological knowledge to inform policy on this question?
How do we balance the need for representation of different ecosystem types with the need to protect large forest reserves?
We need more information about the basic biology and habitat requirements of sensitive species, especially as they vary across different ecosystems.
We need more information about thresholds across spatial scales.
We need to balance reserve networks and sensitive species for thresholds.
Can emulating natural disturbance patterns, rates and processes provide a basis for answering the question of "where and how much" at multiple scales?
Should we focus our conservation efforts only on "high conservation value forests" as defined by the Forest Stewardship Council?

Knowledge gaps and research needs
If protection focuses on "untouched/intact" forests, what is being missed? How appropriate is it (scientifically) to trade-off current vs. future protection?
How will climate change affect the biodiversity/ecology of boreal forests?
More research is needed on the costs/benefits of the TRIAD approach (i.e., zoning the forest into intensively managed, extensively managed, and protected areas).
If we set thresholds for habitat alteration in certain habitat types for sensitive bird species, will this take care of the less mobile species (e.g., lichens, beetles)?
Should reserve systems be fixed or mobile?
Do mobile reserve systems adequately protect less mobile species?
What range of features should be represented when locating reserves?
What is the appropriate distance between reserves – how far can threatened species move? Risks of genetic losses, importance of corridors.
In Canada, the non-harvested land base (NHLB), protected areas and ecological prescriptions (i.e., retaining habitat elements and seral stage distribution) will become the main support for biodiversity. Is this enough?
We need a comparison between areas with dramatically different management histories to help guide us in answering the question of how much and where forests should be fully protected in reserves.
What values should be managed for in the boreal globally, what determines them, and where are there concentrations of high values?
How do we maintain the ecosystem function? What should be measured?
How do the different governance structures meet the three pillars of sustainability?
How are old growth forests different from forests that have been harvested?
What are the implications of deviation from "natural" conditions?
We need large-scale, repeated, landscape level experiments that integrate multi-scale monitoring to determine the relative effectiveness of different methods for maintaining/ restoring biodiversity.

Knowledge gaps and research needs *continued*
How should the mix of matrix and reserves look in the boreal? Can we do a matrix analysis for the boreal?
We need landscape experiments in non-harvested landscapes to investigate habitat elements. These could serve as reference points for adaptive management trials.
We need multi-scale assessments and models.
We need to model the trade-offs between management choices for ecological, social, and economic values.
Opportunities for synthesis and use of existing information
We need to examine regulatory and legislative barriers to biodiversity conservation around the boreal.
Global datasets on conservation and other values are a key industry need, particularly to identify potential HCVFs.
We need to use available information to identify biodiversity hotspots in the boreal.
We need to build a synthesis of the current state of the boreal forests from available information on a global level, and then do a gap analysis to tell us how much is left. This analysis should be coarse scale. This information should be used to inform policy-makers
We should compile an historical retrospective study showing how forest use has changed through time from natural to Aboriginal use to extensive and then intensive management. This will allow us to understand the human footprint on the environment.
We need to stratify the boreal forest into different types of dynamics so that nature conservation targets can be set with a habitat resolution that matches the evolutionary past of species.
We need to synthesize information about how forest use is affecting the health of ecosystems.
We need to synthesize information about natural disturbances patterns, rates and processes across different ecosystems in the boreal.
We should identify sensitive species for different habitat types and then identify habitat thresholds for persistence or reproductive success or other biological response variables.

Opportunities for synthesis and use of existing information
We need to make information on known species-habitat thresholds in particular regions available to the natural resource management community.
We need to identify habitat specialists or processes that are not adequately protected in reserves, on a global scale, and use this synthesis to inform policy-makers.
Our goal should be to provide information to policy-makers regarding the mix. Values such as biodiversity and ecosystem processes should be maintained. We need to consider different scales and conduct ambitious yet integrated and cheap experiments. The generalization of existing results remains a problem.
It would be useful to look at the pan-boreal area and define where the high conservation values are. Finding and synthesizing this information for different organizations is key.
We need to decide if it is more important to conserve intact areas, or whether we should be defining the high conservation values from an ecological perspective (i.e., even if the forest has been disturbed, it could be restored and be more valuable than a currently undisturbed, marginal area).
We could create a map of the boreal broken into different natural disturbance types and assess how far we are from natural disturbance distribution of different seral stages – that would give us an estimate of risk.

Challenges for BorNet

- Goals: Answering the question of how much forest needs to be fully protected in reserves depends on a clear definition of the goals of forest management.
- Language: English-speaking researchers know little about Russian research. Some funding should be put towards translation of these materials.
- Benchmarks: We have problems with defining reference points for benchmarks.
- Communication: We need effective communication systems between researchers and users of information. Do we have the political and forest management learning situations that allow changes to occur?
- Education and public values are integral to any conservation efforts, especially where a lot of harvesting is on private land.

What is the goal of forest management?

Following the break-out groups, participants had an involved discussion around defining the goals of forest management. It was agreed that the question of "how much is enough" is difficult to answer without a clear definition of the goals. While defining goals for forest management is clearly not a function that a group like BorNet can fulfil, it represents a major barrier to scientists who are asked to answer this question by policy-makers and industry representatives. One possible solution could be to

define different goals and answer the question, thereby allowing forest managers and policy-makers to make informed trade-off decisions about how much they choose to fully protect and where. The points below summarize the discussion that occurred after this session.

- The goal of forest management should be biodiversity conservation and sustainable communities, not timber management. If we shifted our perspectives in this way, we would not focus on mitigating impacts of forest management and looking at biodiversity as a constraint upon timber harvesting. While a shift in thinking has occurred in this direction in some European countries and the U.S. (for National Forests), the major timber-producing countries are yet to accept such a fundamental shift in paradigm.
- This shift would be difficult in different contexts. In Europe, only some of the land is publicly owned. Landowners define the goals, and the main goals are timber production and pulpwood production.
- The logic for this paradigm shift is sound, but the priority of economic arguments is entrenched in our society. We have made economic and social decisions in North America, particularly in western North America, that have created infrastructure (towns, mills, etc.), making it very difficult to change.
- As ecologists, we have a good understanding of fine-scale issues. However, we need to come up with general recommendations for policy. This is why BorNet should involve social scientists and economists.
- Changing the goals from timber supply to ecological goals would be a huge paradigm shift, but this could be the start of something quite fundamental in how we relate to our forests. Indigenous people might support policy changes.
- Ecology should shape the limits of forest management, not economics, and scientists can help policy-makers by telling them where these limits lie. How much is enough will vary depending on the ecology of the area in question. If we depart from the ecological limits, we should recognize that there would be adverse impacts on biodiversity.
- We need to agree on a general ultimate goal, but we need to think in terms of gradients, rather than thinking in black and white terms, particularly as there are many different socio-political contexts around the world.
- We should be free to identify structures and functions across the landscape independent of the current economic context, recognizing that in order to have sustainable forest management, we will have to pay (i.e., there will be economic implications).

Heath spotted orchid, one of a number of orchids found in European boreal forests JOHN INNES PHOTO

3.1 Integrating biodiversity conservation into forest planning and operational practices in Canada

Luigi Morgantini, Weyerhaeuser Company, Alberta, Canada

ABSTRACT: It is generally believed that disturbances have shaped present natural boreal forest landscapes in Canada and contributed to the current complex mosaic of vegetation patches varying in size, composition, age-structure and distribution. Depending on site-specific environmental conditions (e.g., soil, topography, climate), plants and animal species occur in different assemblages (communities) according to the stage of succession, the time-since-disturbance, and the scale (i.e., extent, intensity) of that last disturbance. To some degree, species are adapted to the disturbance regime of the region they inhabit. Hence, it is widely believed that the long-term sustainability of these forest ecosystems and the ecological requirements of most species can be addressed by emulating the inherent natural processes of disturbance and succession characteristic of a site and/or a region; that is, by maintaining a variety of stand sizes, seral stages and stand attributes and structures across landscapes, within the range of natural variation in the system.

The landscape structure resulting from a natural disturbance regime is suggested as the model against which existing landscapes can be compared. However, defining a "natural regime" is difficult, if not impossible. Landscapes are dynamic by nature. They change as a result of changes in physical and ecological conditions, or through stochastic disturbance events (fire, insect outbreaks, etc.).

Despite the uncertainty surrounding the effectiveness of following the natural disturbance model to address the conservation of biodiversity, there is an urgent need for forest management in Canada to ensure that current practices do not leave forest ecosystems devoid of structural diversity and in simple, uniform landscapes with a truncated age class distribution. Current landscape patterns can act as an initial benchmark to compare management scenarios against where timber requirements, as well as wildlife habitat, biodiversity conservation, recreational demands and aesthetic consideration are addressed. A pragmatic approach to structure retention in harvest sites, the creation of a range of patch sizes in operating areas and the maintenance of late seral stages can be easily implemented. While species and ecosystem thresholds are not fully understood yet, any

MORGANTINI: KEY MESSAGES

- Forest management must ensure that it does not leave managed forests devoid of structural diversity and in simple, uniform landscapes with a truncated age class distribution.
- We should use current landscape patterns as an initial benchmark against which to compare forest management scenarios.
- It is not certain that long term sustainability of forest ecosystems and ecological requirements of most species can be addressed by following the natural disturbance template.
- We need to start using available thresholds, even though information is not perfect.

change from current practices will benefit a range of wildlife species whose habitat is now negatively impacted by current forest management practices focused on fibre production. Monitoring the response of processes (nutrient dynamics, etc.) and of plant and animal communities will provide a measure of success.

Discussion

If you want scientists to tell you the answer to "how much is enough," we need to define what it is exactly that we are trying to do. Industry is in a difficult position. On the one hand, scientists tell us we have to address biodiversity conservation or that we may not leave enough; on the other hand, we have to listen to the public and public values (e.g., aesthetics) since we operate on public land. Public values as represented by public advisory groups may not coincide with what science and the scientists tell us.

Suggestion from audience: Industry could provide us with a lot of coarse-filter information about what is happening that would help us assess where we are now. Industry should present different scenarios, and attach risks to these scenarios (e.g., risk of local species extinction, etc.).

Harvesting black spruce in the boreal forest. Northern Ontario, Canada. JOHN INNES PHOTO

3.2 Sweden's strategy for managing its national forest

Stefan Bleckert, Sveaskog, Sweden

ABSTRACT: Sweden has 3.3 million hectares of formerly state-owned forests that are now run through a state-owned company called Sveaskog, making it the largest landowner in Europe. At the present time, 90 to 95 per cent of the land in Sweden is managed as industrial forest land, which in part explains why there are approximately 2,000 red-listed species.

Although Sveaskog is certified to the Swedish national FSC standard, this standard is not enough to conserve biodiversity. To help restore more natural levels of biodiversity in the forests, Sveaskog has decided to do something new: create nature reserves on key areas within the Swedish landscape, and set aside 20 per cent of the productive forest in each forest region as managed forest with a conservation emphasis. If this target is met, it will amount to 600,000 ha of conserved land in Sweden. As the "on the ground" plan will differ across regions because of ecological variation, Sveaskog will consult with ecologists to develop appropriate plans. This project is called "BIOMAN."

The BIOMAN project classifies landscapes according to four categories, which apply to every stand within the landscape:

- Natural untouched;
- Natural managed;
- Production with intensive conservation (about 50 per cent of the land for conservation); and
- Production with general conservation (not more than 10 per cent of the land for conservation).

Why 20 per cent? This number is based on the best available information. Follow-up monitoring will be done to assess how well the plan is working. Although the follow-up monitoring has not yet been designed, the end result will be to track biodiversity through the use of key species that need particular forest habitats.

BLECKERT: KEY MESSAGES

- Sveaskog is FSC-certified, but this standard is not enough to conserve biodiversity.
- Sveaskog is creating nature reserves across the landscape.
- It is uncertain whether 20 per cent forest with a conservation emphasis is enough. Will this effort restore/recreate biodiversity?

Discussion

Finland is preparing a similar project, but monitoring will be for more than just species. There was general agreement that Finland and Sweden should cooperate on the development of these strategies, and learn from each other.

We need to improve the dialogue between research and practice. Within Sveaskog, the plan is to have one biologist and one forester working together to ensure that this dialogue occurs. Biologists and scientists need to work on the ground with foresters to improve the level of communication.

3.3 Literature review on biodiversity research in Finland

Petri Ahlroth, Ministry of Agriculture and Forestry, Finland

ABSTRACT: A recent literature review examined approximately 30,000 articles worldwide from 1975 to 2000. This review has revealed variations in the extent to which different conservation methods have been studied. By way of a solution, the Finnish government proposes to increase funding to fill knowledge gaps on methods for which we know less.

Discussion

In Canada, we do less research on island biogeography theory than in Europe, because our landscape is less fragmented. Instead, we have a complex mosaic of habitats. However, Canadians need access to European information to keep us from going in the same direction.

This style of cutting, involving two passes, has replaced clear cutting in some areas. Kirakka, Finland. JOHN INNES PHOTO

3.4 Suvi Raivio, Biodiversity Specialist, Finnish Forest Industries Federation, Finland

The principal methods to restore/recreate/maintain important features in the Finnish managed forests are the protection of key habitats, green tree and dead wood retention, increasing the proportion of deciduous trees, and prescribed burning. In addition, landscape ecological planning is used in state-owned and in some company-owned forests. All these methods need refinement from ecological, silvicultural and economic point of views. The challenge for research is to find solutions that are ecologically relevant, feasible in practice and not too costly.

3.5 Jan Volney, Research Scientist, Canadian Forest Service, Northern Forestry Centre, Alberta, Canada

Forests dominate the Canadian landscape and largely define the character and quality of the environment. However, the forest products industry contributes considerably to the economy of Canada. In contemplating sustainable forest management, a means to protect and conserve the biota while maintaining the economic viability of the forest industry is a challenge that can best be met by balancing the depletion equation. A necessary condition for sustainability is to ensure that depletions due to anthropogenic and natural causes do not exceed net annual primary productivity of the forest estate. Fortunately, large tracts of Canada's boreal forests remain unexploited, providing opportunities to exercise policy options. Nevertheless, current allocations of timber licenses and projected development suggest that this flexibility will soon be curtailed. A TRIAD approach could focus intensive forest management on marginal agricultural lands to balance the need to establish protected areas on the land base currently scheduled for extensive forest management. This approach will have to consider the biophysical limitations imposed by natural disturbance regimes as well as the socioeconomic constraints arising from forest policies of the several provincial governments that collectively control 71 per cent of the forested land base.

3.6 Russell Graham, USDA Forest Service, Rocky Mountain Research Station, United States

The best way for management to effectively restore/recreate/maintain biodiversity is by making informed decisions using properly scaled information that has the appropriate resolution and is supplied by credible scientists, such as those associated with BorNet.

Russia, Fennoscandia (Norway, Sweden, Finland), United States (Alaska), and Canada contain the majority of the boreal forests. In addition to these diverse political entities, the boreal forests support many populations of indigenous people (e.g., Sámi, Oroks, Nenets). Now, more than ever, these systems are supplying raw materials to the economies of the world. In some circumstances (e.g., Estonia), former Soviet Union members are using forests to develop their countries, which in turn cause declines in populations of native wildlife. For management to effectively restore, recreate or maintain features that conserve biological diversity within this highly diverse political and biophysical landscape their actions (or inactions) must be placed within the context of the political, economic, social and biophysical settings in which they occur.

For the foreseeable future, boreal forests will supply wood and fibre to the world from nations with both developed and developing economies. In addition, values other than timber such as wildlife, carbon sequestration, climate change, First Nations' rights, biological diversity conservation, and others will continue to emerge and influence how boreal forests are managed. This management (e.g., fire exclusion, harvesting, reserves, gas and oil development) will be determined in the political arena (local to international). The role of science is to inform political (management) decisions on restoring, maintaining or creating important features required to conserve biological diversity. To be effective, the science needs to be objective, relevant and applicable at multiple spatial and temporal scales.

At the broad (national to international) and mid (regional to national) spatial scales, decisions are being made if, when, how and where to develop, harvest or preserve the boreal forests. These decisions will have the utmost impact on the biological diversity of the boreal forests. Science, and in particular BorNet, is in a position to supply information for making these decisions. Information is needed at these scales to describe, understand, view and locate elements of biological diversity. Most importantly, combining, summing, or scaling up fine-resolution data collected at small scales will not be applicable at these broad scales. The cost of attempting to collect and summarize fine resolution data for use at broad scales would be outrageous.

There are many potential research questions for understanding biological diversity at the broad and mid spatial scales.

What structural and compositional vegetation classifications of boreal forests can be used (developed) at broad and mid spatial scales that contain (disclose) important elements of biological diversity?

Observable at the broad and mid scales (of the boreal forests), what are the native and non-native disturbances (harvesting, climate change, fire, insects, weather, diseases) and their interactions occurring in boreal forests and what are their trends? What are their temporal dimensions? How is biological diversity affected by these disturbances? Are there elements that depend on disturbance and if so what are their temporal and spatial dimensions?

What are the successional pathways occurring in the boreal forests and how are they affected by the array of disturbances that occur in the boreal forests? What are their temporal dimensions? Will a network of preserves remain static to ensure that biological diversity is conserved?

These are only a sample of the questions that need to be addressed at the mid and broad scales that will inform policy-makers (e.g., industry, government) making decisions on the use and preservation of the boreal forests. Data and information need to be collected, analyzed and reported using the proper

resolution for the question and scale being addressed. If information is available to answer these or similar questions at the appropriate scale, then BorNet needs to highlight its existence to the policy-makers and other organizations concerned about biological diversity in boreal forests. Moreover, the presence or lack of information will define information and research needs.

At the fine scale (stand), biological diversity can be addressed when the broad and mid scale views of the boreal forests identify areas of importance, uniqueness, or elements of biological diversity that need further understanding. The broad and mid-scale views of biological diversity provide context and relevance of the processes and structures occurring at the fine scales. Under no circumstances will fine-resolution data taken on small scales address the many issues facing biological diversity of the boreal forests occurring at the national and international scales.

In addition to understanding biological diversity within stands, it is very important to understand the effects that treatments within stands are having, not only on biological diversity, but also on the resource itself. For example, in Russia and to a lesser extent in Estonia, the application of good forestry practices and an understanding of different potential vegetation types, their disturbances, and successional pathways would be as beneficial to biological diversity as establishing a reserve network. Proper haul road location, construction, and maintenance for timber harvesting would be highly beneficial to conserving water and soil resources in the Russian forests we visited. Similarly, harvesting, site preparation and other silvicultural treatments (cleaning, weeding, planting, prescribed fire) that are properly located, timed and applied to meet the objective of producing timber would be highly beneficial to forest productivity, timber production and biological diversity.

By addressing biological diversity at a variety of temporal and spatial scales, BorNet can be the leader in supplying information for making informed decisions on boreal forest management (use and preservation). Policy-makers ranging from the European Union to First Nations in Canada are making decisions affecting the use and preservation of boreal forests. BorNet can be the definitive source of credible, appropriately scaled, and timely information.

Boreal forest wetland. Northern Ontario, Canada. JOHN INNES PHOTO

SESSION III: SUMMARY OF COMMENTS AND DISCUSSION "HOW CAN MANAGEMENT EFFECTIVELY RESTORE/RECREATE/ MAINTAIN IMPORTANT FEATURES REQUIRED TO CONSERVE BIODIVERSITY?"

THE BREAK-OUT GROUPS AND SUBSEQUENT DISCUSSIONS IDENTIFIED A NUMBER OF POSSIBLE synthesis projects and research opportunities associated with the question of "how can management effectively restore/recreate/maintain biodiversity." These are summarized in the section below, along with others identified through the presentations and discussions that followed each presentation. Many of these ideas build on suggestions from the previous session. A remaining task for BorNet is to prioritise these research and synthesis possibilities into a list of projects that may be accomplished in the following phase of BorNet.

Through the discussions in this session of the workshop, it became clear that although scientists have a lot of information about how management can effectively restore/recreate/maintain biodiversity, a key challenge is the lack of an effective means to transfer this knowledge to the operational community. As the political and ownership contexts are different across the member countries of BorNet, solutions for this issue will be necessary on a national and regional scale, and are not an issue that can be directly addressed by BorNet.

What we know

- We have a good understanding of stand level concerns regarding maintaining key habitat elements.
- We know a lot about methods for maintaining/restoring biodiversity.

Knowledge gaps and research needs
More information on the basic habitat requirements of many species, including arthropods, is needed.
More information on the relative effectiveness of different methods for maintaining/ restoring biodiversity is needed.
Can the natural disturbance template be used to define appropriate rates and patterns of forest harvesting to guide how management can maintain biodiversity on a landscape scale?
Can an index of biodiversity be developed at the broad and mid scales that uses structural and compositional vegetation classifications of boreal forests to represent important elements of biodiversity?
We need to examine current disturbances and trends across the boreal, and study how biodiversity is affected by these disturbances.
We need to characterize successional pathways occurring in boreal forests and examine how they are affected by the array of disturbances that is present.

Knowledge gaps and research needs *continued*
Concerning the distribution of responsibility for the conservation of biological diversity, should it be equal in all jurisdictions or distributed according to ecological criteria or the availability of unallocated land? If it is equal in all jurisdictions, how do policy-makers compensate industry or private landowners for conservation needs?
The TRIAD approach is one solution to the question of how management can be arranged to effectively maintain biodiversity while also maintaining timber supply. This approach designates areas for extensive and intensive forest management, and leaves some areas protected. In Canada, there is interest in using non-productive farmland for intensive forest management, and for increasing the productivity of already established intensive management zones. From an economic perspective, there is a need for roads, mills etc. to be located near these areas.
Opportunities for synthesis and use of existing information
We need to develop structural/compositional vegetation classifications of boreal forests and broad and mid scales to represent important elements of biodiversity.
We need to use the available information to define natural disturbance patterns across different ecological types in the boreal, and make this information available to guide rates and patterns of forest harvesting.
We need to use current landscape patterns as an initial benchmark against which to compare forest management scenarios and attach risks to these scenarios.
We need to supply information to policy-makers to describe, understand, view and locate elements of biodiversity at the broad and mid scales (i.e., national and regional scales) so that informed decisions can be made about if, when, how and where to harvest, develop or preserve.
BorNet should develop a series of case studies in which biodiversity maintenance/restoration has occurred within different ownership contexts and make this information available on-line.

Challenges for BorNet

We know a lot about how management can effectively restore/recreate/maintain biodiversity, but we have challenges with implementing this information in practice. A key problem for BorNet in answering this question is that management contexts vary, with some countries operating largely on private land and others operating under tenure systems on public land. We need to understand the different challenges to changing policy and practice that this represents in different countries.

Most changes in management occur at the community level; it is beyond the scope of BorNet to affect these changes.

Education is very important as a means to change attitudes. We have a lot of knowledge about these issues and we need to change things in practice. Techniques used in Sweden to change the approaches of private landowners might be transferable to North America, even if the audience is different. We need practical tools (e.g., the HCVF toolkit), but these are mostly still under development.

4.1 Biodiversity performance indicators

Stan Boutin, University of Alberta, Canada

ABSTRACT: The challenges in producing an effective biodiversity monitoring program are daunting and include the selection and definition of indicators, determination of realistic performance benchmarks, and implementation over effective space and time scales. To date, much of the scientific discussion has focused on broad conceptual issues around program scope and indicator selection. There are few examples of operational biodiversity monitoring programs where sampling regime, explicit indicator definition, and performance benchmarks have been clearly outlined and implemented. I will discuss issues around each of these aspects with specific reference to a program developed for monitoring biodiversity in one province in western Canada. The intention is to generate discussion around how programs can be rendered operational (economically and logistically feasible), how they can have a lasting legacy, and how performance benchmarks could be made explicit. Finally, I hope to generate some discussion around whether it is feasible for an organization like BorNet to generate a common set of biodiversity indicators that could be reported across the entire circumpolar boreal forest.

Discussion

Can we establish a common set of indicators across the boreal and put performance benchmarks on them? BorNet should establish the range of variation across the boreal due to different levels of human practices and develop ecological dose-response curves across the boreal.

BorNet should not establish targets. It is the role of politicians to establish targets, based on public interest. Nature should be the benchmark.

Are individual species the correct level at which to be monitoring? Would it be more appropriate to use the level of genus or family?

Have you done a literature review on the usefulness of indicators?
Not ourselves, but a similar research project is being done by Stig Larsson at the Swedish University of Agricultural Sciences (SLU). The result of this review seems to be a high degree of scepticism around the indicator species approach.

BOUTIN: KEY MESSAGES

- There are few examples of operational biodiversity monitoring programmes.
- Can we develop a common set of biodiversity indicators for the boreal?
- Systematic sampling should be used for monitoring programs.

4.2 BorNet achievements in Finland

Lauri Saaristo, University of Helsinki, Finland

Authors: Lauri Saaristo and Jari Niemela, University of Helsinki, Finland

ABSTRACT: The BorNet national synthesis phase has been carried out in Finland by the BITUMI-project (Applicability of Biodiversity Research), which is an integration project of the Finnish Biodiversity Research Programme FIBRE. One task of the BITUMI-project is to arrange and coordinate the meetings of the working group of forest managers and researchers. We used this working group as a forum to discuss how we can determine the effectiveness of biodiversity conservation efforts.

Since the development of alternative silvicultural methods in the 1990s, forest managers have been wondering if the new practices are able to reverse the previously declining trend in the biological diversity of forest flora and fauna. Potential biodiversity indicators have been listed in some national processes, e.g., in the development of criteria and indicators of sustainable forest management and forest certification.

We organized three meetings for this one question. In the first meeting (December 2001), the results of the pan-European indicator project BEAR and the existing Finnish forest biodiversity monitoring processes were presented and discussed. In the second meeting (March 2002), we heard presentations about the practical challenges in forest biodiversity monitoring. Before the third meeting, we asked FIBRE researchers to give us their opinions about developing biodiversity indicators and using them as practical tools. The answers were presented in the third meeting (May 2002).

The meetings highlighted the existing situation, future possibilities and knowledge gaps of biodiversity monitoring and indicators in Finland. Biodiversity monitoring can be based on two complementary approaches: species monitoring and habitat monitoring. Based on current scientific knowledge there are reasons to regard with suspicion the idea that we could monitor some kind of indicator species and trust that those would inform us about changes in other taxa. A recent pilot project in Finland aims to find suitable species groups and methods for forest biodiversity monitoring by using habitat indicators. The project aims to find links between stand structure and species composition of different taxa. In the long term, it should be possible to explain and predict the changes and trends in species diversity by the changes in forest structural characteristics.

SAARISTO: KEY MESSAGES

- Forest managers in Finland recognize the need for biodiversity monitoring.
- Biodiversity monitoring programs should include species and habitat indicators.
- Indicator species may not adequately represent how other taxa are affected.
- Future ecological research in Finland will gain knowledge about possibilities for developing existing habitat monitoring systems towards sound forest biodiversity monitoring.

4.3 Using landbirds to assess the effectiveness of ecosystem management in the boreal forest of eastern Canada

Pierre Drapeau, University of Quebec at Montreal, Canada

Authors: Pierre Drapeau and Alain Leduc, University of Quebec at Montreal, Canada

ABSTRACT: Within Canada and internationally an increasing demand that forests be managed to maintain all resources has led to the development of criteria and indicators of sustainable forest management. There is, however, a lack of knowledge at an operational scale to evaluate and compare forest management activities to ensure the sustainability of all resources. We recently proposed an integrated approach to developing standards based on an ecosystem management paradigm, where the variability inherent in natural systems is used to define the limits within which forest management is ecologically sustainable. Standards for biodiversity were proposed and two types of indicators were developed: forest condition indicators (age structure and stand composition) and effectiveness indicators (landbirds). In this talk, even though we advocate that traditional fine-filter approaches applied to single species are necessary when addressing biodiversity issues in the boreal forest, we examine how landbirds can be considered a "multiple species" indicator for assessing the effectiveness of ecosystem management implementation across the landscape of large management units. We focus on the rationale of this approach and discuss the importance of using both types of indicators in the assessment and continual improvement of sustainable forest management.

DRAPEAU: KEY MESSAGES

- In Canada, we need to focus on changes in populations, not on species loss.
- Species loss and habitat thresholds *should* be given attention, but we should also concentrate on the effects of changes in forest species composition and age distribution.
- We need to focus indicators on more than just presence/absence data. We need demographic parameters of breeding activity, information about population dynamics, dispersal, and factors that regulate populations.

4.4 First Nations monitors and measures of forest biodiversity

Marc Stevenson, Sustainable Forest Management Network, Canada

ABSTRACT: The development of measures of forest biodiversity has attracted a wide variety of interest, from environmental scientists to forest companies committed to sustainable forest management. Built on the best of western scientific practice, the development of biodiversity indicators has been, and continues to be, based primarily on ecological criteria. Excluded from consideration and analysis is the role of human beings in sustaining the health of ecosystems and maintenance of biodiversity. For many of Canada's First Nations peoples, biodiversity and ecological integrity are concepts that are difficult to separate from notions of culture, spirituality, economy, society, rights, etc. Indeed, many of Canada's Aboriginal peoples traditionally viewed themselves as part of nature and integral to the "proper" functioning and health of ecosystems. This presentation develops the arguments that: 1) the relationships that First Nations peoples traditionally maintained, and in many cases still wish to sustain, with their environments constitutes a fruitful area for biodiversity indicator research; and 2) Aboriginal peoples may be particularly well-suited to monitoring biodiversity indicators developed by them, as well as those of ecologists and other scientists. The presentation concludes with a few examples of Aboriginal biodiversity indicators and consideration of such indicators within the context of forest certification.

Discussion

How can you address the problem that, when communities change, they often become dependent on technology and are no longer sustainable in the traditional sense? These new values are part of management and regulation. There are some situations where changes in communities include a range of non-Aboriginal interests and stakeholders, and these communities are more complex.

It was interesting how you presented the two corresponding bodies of information (western science and traditional ecological knowledge) as separate streams that should be used independently for informing policy and practice. This model would be even more powerful if it included technological knowledge (i.e., information that comes from modelling) as a separate stream, and if you considered how knowledge changes over time. All of these decisions are made in the political arena; we are trying to provide the best information that we can to inform these decisions.

How big was the role of Aboriginals in determining fire history? It was huge. The use of fire by Aboriginal people has been clearly documented to have contributed enormously to shaping forests in Canada.

Are these fires considered natural disturbance? We are struggling with the natural disturbance paradigm – where are the benchmarks and what is "natural"? What is natural is moot. The issue should be: What are we managing, how do we sustain it, and how do we allow knowledge to inform these processes? We need to focus on the best available knowledge.

STEVENSON: KEY MESSAGES

- The ability of First Nations peoples to maintain their relationships with their environments may be an important indicator of ecological integrity.
- Aboriginal people are particularly well-suited to monitoring biodiversity indicators developed by them, as well as those of ecologists and other scientists.
- Aboriginal people had dramatic effects on their environment, through purposeful burning of forest areas. Whether these fires are considered natural disturbances is irrelevant: We need to focus on what we are managing, how we sustain it, and how we allow knowledge *from all sources* to inform these processes.

4.5 Bjørn Åge Tømmerås, Norwegian Institute for Nature Research

The development of indicators will be a never-ending process. Effectiveness and relevance can always be improved. Therefore, the challenge of how to use the indicators in management practices in a continuous process of improvement is important. But, how? The relevance of indicators has always some constraint that can be counteracted by other systems or decisions. How can we ensure that efforts are not focusing on "fulfilling" indicators and thereby also reducing the relevance of the indicator as an aid to determining biodiversity conservation efforts?

4.6 Allan Watt, Centre for Ecology and Hydrology, Banchory, U.K.

An assessment of the effectiveness of biodiversity conservation efforts requires, first, a clear statement of goals. Far too often, the goals are unstated, added afterwards or are either too narrow or too broad. These goals should be specific to each spatial scale. Second, we need means of monitoring biodiversity that are clearly linked to those goals. Furthermore, monitoring must provide data that can accurately reflect changes in biodiversity. Inevitably, indicators will often have to be used, but the desire for cheap methods of monitoring must not result in indicators that fail to provide useful information.

In developing indicator systems, we should refer to ongoing and relevant initiatives, rather than reinventing another set of indicators. Some projects with useful information include: the Convention on Biological Diversity, OECD, TBFRA, MCPHEE, ICP-Forests, NGOs, and BAPs and Directives from the EU.

Research projects

BEAR has had an impact on inter-government processes in Europe (e.g., dead wood). Many indicators are related to remote sensing (ENVIP-Natur, EON2000+). BioAssess is a partnership of 24 groups developing indicators under the European 5th Framework. This project aims to develop a toolbox for assessing the impacts of policies on biodiversity in Europe and to quantify the impacts of land-use change on biodiversity.

4.7 Susan Leech, FORREX – Forest Research Extension Partnership, Canada

The key management challenge to implementing monitoring systems is to ensure that two questions have been addressed before significant resources are used to design programs and gather information:

1. What are the goals of our forest management practices?
2. How can we learn and change practices from the information we collect?

For monitoring to be useful, we must have a clear idea of what end result we are trying to achieve. Indicators need to tell us if we are achieving that goal, and forest managers need to be able to integrate what they learn from their monitoring programs to adapt their forest practices.

Implementing effective adaptive management programs requires an important shift within industry and government. Forest companies need to recognize that constant learning and innovation must be part of their corporate cultures, while policy-makers need to provide forest managers with the flexibility to change and adapt forest practices as required. Researchers need to find ways to ensure that their new information is also incorporated into both of these sectors, to create a continuous learning cycle within the natural resource management community. How we integrate researchers' learning cycles with the practice and policy-learning cycles will be different in each country because of different contexts.

SESSION IV: SUMMARY OF COMMENTS AND DISCUSSION "HOW DO WE ASSESS THE EFFECTIVENESS OF OUR BIODIVERSITY CONSERVATION EFFORTS?"

DISCUSSIONS FOLLOWING THE PANEL SESSION IDENTIFIED A NUMBER OF POSSIBLE SYNTHESIS projects and research opportunities associated with the question of "how do we assess the effectiveness of our biodiversity conservation efforts." These are summarized in the section below, along with others identified through the presentations and discussions that followed each presentation. Many of these ideas build on suggestions from the previous sessions. A remaining task for BorNet is to prioritise these research and synthesis possibilities into a list of projects that may be accomplished in the following phase of BorNet.

What we know

- We need benchmarks against which to measure our progress towards biodiversity conservation within actively managed forests.
- Biodiversity monitoring should include species and habitat indicators.
- Many other processes (e.g., CBC, BAPs and Directives from the EU, CCFM, OECD, TBFRA, MCPHEE, ICP-Forests; NGOs) have identified a number of potential indicators of biodiversity conservation; we should build on these lists.

Knowledge gaps and research needs
We need more information around indicators, particularly coarse-filter indicators. How many/what kinds of indicators are enough? Should they be associated with some sort of risk measurement of achieving the stated goal?
We need better indicators of ecosystem function.
We need to know how well indicator species represent other taxa.
We need to explore the life forms approach.
We need to develop indicators for more than just presence/absence – e.g., indicators of breeding activity, population dynamics, dispersal, and factors that regulate these processes.
We need a comparison of the relative usefulness of different indicators.
We need a shopping basket of indicators that incorporate a combination of structural and habitat indicators.

Opportunities for synthesis and use of existing information
We should use existing data and satellite images to select a number of indicators of forest ecosystem functions.
We need to generate a common set of biodiversity indicators that can be reported across the boreal, and put performance benchmarks on these indicators.
We need to develop an indicator system based on species groups and habitat indicators. In the long term, we could use changes in forest structural characteristics to predict changes and trends in species diversity.
We should recommend indicators that are relevant to society. Indicators should reflect changes, and tell policy-makers whether we are on target or going in the wrong direction. We should give a lot of priority to promoting useful, generic indicators that can be customized for different areas.

Challenges for BorNet

- Is it feasible for BorNet to generate a common set of biodiversity indicators that could be reported across the entire circumpolar boreal forest?
- How should Aboriginal communities and other social values be incorporated into BorNet?

Norway spruce forest. Rovaniemi, Finland. JOHN INNES PHOTO

Appendix 1: Break-out group summaries

Break-out Group 1

Session 2: How much and where should forests be fully protected in reserves?

There should be a focus on coarse filters – *ecosystem diversity and structure*. Too much effort is focused on figuring out whether species are lost. We need to look at other indicators as well. We should be putting effort into defining how old growth forests are different and thinking over multiple scales and multiple measures of integrity.

For example:

	Trees	**Stand**	**Landscape**
Composition			
Structure			
Function			

One idea for a synthesis product is to look at how much is not enough. We need to make a synthesis of available information on boreal forest management from a global perspective and make this information available to policy-makers. This would essentially amount to a gap analysis for the boreal, from a global perspective, and would answer the question: How much intact forest is left? If we do this, we need to think about scale – it should be on a coarse scale and should guide where finer scale studies are necessary.

We need benchmarks for comparison purposes: What are the implications of deviation from "natural"? On a species level, it is well documented in Finland how forestry affects species.

Session 3: How can management effectively restore/recreate/maintain biodiversity?

Most people do not understand the barriers to implementing policies in different boreal countries. To address this issue, we can find existing case studies across boreal countries that represent differences in land ownership/management. One project could involve mapping ownership patterns across the boreal, then looking at case studies to illustrate how biodiversity conservation initiatives are implemented in different ownership patterns. This project would enable us to learn from one another and understand barriers in different areas. It could illustrate solutions to different barriers, and therefore be helpful to people working within communities in these different ownership conditions. Documenting this information also allows us to understand our own thinking constraints, by looking at the full range of possibilities. Country level mapping of this information does not exist in Sweden; Alberta and Finland are starting to do this.

What would be the goal of this kind of synthesis and mapping ownership patterns across the boreal? Each of us is somewhere on the x-axis (i.e., the gradient of forest disturbance from natural to intensive forest management, with differing degrees of habitat loss and fragmentation). Mapping management conditions and ownership patterns across the boreal allows us to broaden the x-axis and ask important questions that can be answered by the gradient of conditions across the boreal. The map could be further broadened by including an altitudinal gradient of boreal forests – we would need to include European countries that have high-altitude boreal forests.

BorNet could also sponsor exchanges between people in the field to understand different management conditions across the boreal. Is education part of BorNet? This question should be answered by the BorNet steering committee.

Session 4: How can we monitor the effectiveness of our biodiversity conservation efforts?

There was no break-out group on this topic, but Per Angelstam presented his ideas of the next step for BorNet. This presentation is summarized below.

Next steps for BorNet

Develop a research and communication programme on adaptive management for the boreal forest

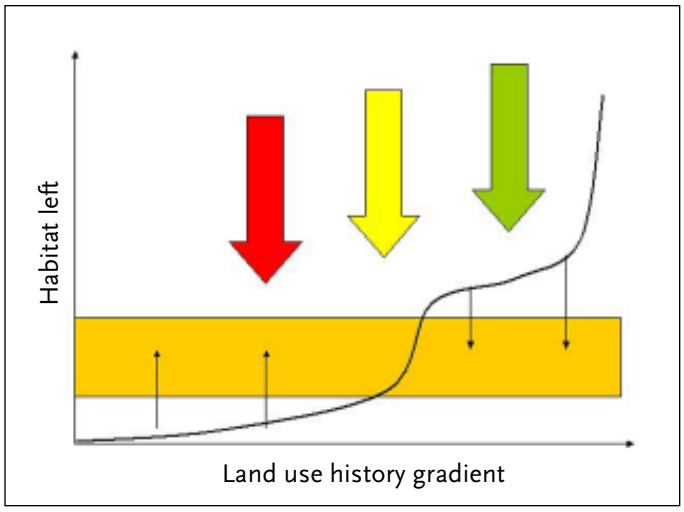
Can we agree that:

- Habitat loss (and configuration) at multiple scales is the main problem for the loss of forest biodiversity;
- This group of people represents an important resource for inter-continental boreal co-operation for sustaining that ecosystem; and
- There are several good real-world case studies that can be used?

Our asset: The Boreal Forest Laboratory

- Across the boreal, we have several case studies with proactive managers (= forest management units).
- The status of biodiversity is different across countries in the boreal.
- There are different socioeconomic settings among boreal countries.
- We have some evidence from research that thresholds do exist.

- We can illustrate the full range of variation with the boreal forest through a series of case studies, and map habitat thresholds through this variation.



- One of our goals should be a gap analysis across the boreal forest. This gap analysis should include both horizontal and vertical elements – i.e., ecosystem gaps *and* policy and institutional gaps.
- What purpose will this information serve?
  - It will tell us the extent to which we strike a balance between the use and conservation of nature.
  - It will help us to understand our own thinking constraints.
  - It will enable us to understand our position along the gradient of change from the ecological benchmark.
  - We can use these case studies for mutual education among different boreal countries.

Three original BorNet questions

- "Reserves" at multiple scales – how much and where?
- How can management effectively restore/re-create/maintain important features?
- Indicators, targets and systems for monitoring and assessment; how can we develop these?

Future work for BorNet

- Develop long-term monitoring systems for all species within particular groups (e.g., beetles).
- Broad picture – current status, trends, likely directions. Where are the real problems? What is really going on? What do we need to solve these management problems?
- Synthesize what knowledge we have. What can we implement now? Why is knowledge not being applied?
- Develop a framework for BorNet, structured with particular themes.
- Build on the European BEAR project results.
- Set up tests across the boreal to make use of comparisons.

- Improve knowledge exchange internationally and within countries.
- Are we using the right tools? Critical thinking is needed.
- What scientific and practical products do we want from all of this?
- International exchange at all levels and for all disciplines should be taking place.
- One possibility is twinning of companies such as Alpac in Canada and Sveaskog in Sweden.

Chapters to BorNet

- Current status/synthesis (= maps)
- Ecological research – threshold ranges (= threshold ranges)
- Monitoring and assessment (= trends)
- Knowledge exchange (= positive change)

Break-out Group 2

This group focused on the research process/framework.

Our break-out group proposed developing BorNet further through focusing on the specific question: What should the mix of matrices and reserves look like across the boreal in order to maintain ecological function? The ultimate goal for biodiversity conservation is to minimize the risks of extinctions. Our null hypothesis would be something like: the harsher the matrix, the more important the configuration of protected areas (including linkages, etc.). We would also need to assess whether the current mix of the matrix and protected areas is working (by casting back among different gradients of forest intensity). This would be accomplished through modelling, large-scale experiments and monitoring.

We recognized the added value of working among boreal countries with different management contexts. Further comparisons will help identify specialists or processes not adequately protected in reserves.

There are challenges to this approach, including differences between public and private land ownership and temporal dynamics across the boreal.

Our goal is to provide information to policy-makers regarding the mix between matrix and protection. Are policies in the European Union and North America working? What can we learn from each other? Are the reserves working? Where should we place new reserves? How do governance and institutions affect the mix of matrix and reserves?

BorNet's potential role in facilitating communication is key. We would like to propose that the EU and other funding sources in Canada be approached to fund a BorNet process to develop common understanding and common ground. Further, we must learn more about the different political and ecological contexts in boreal countries. Finally, it is key to learn from other processes such as the BEAR project.

Break-out Group 3

Session 2: How much and where should forests be fully protected in reserves?

We need applied science to answer this question. How much you need depends on the services you are trying to get from the ecosystem in question; the answer should balance social, economic, and ecological needs. It is hard to answer this question without determining what values you are trying to maintain in the forest. This group recognized that these values are probably different around the world. As far as changing current protected areas status in different regions, it was agreed that different areas of the boreal have quite different challenges. It is particularly challenging to accomplish this shift in management focus in areas with many private landowners. How are costs shared and how are protected areas implemented on the ground?

Session 3: How can management effectively restore/recreate/maintain biodiversity?

This break-out group generally agreed that researchers have a very good sense of what information we have and what we are lacking. However, we do not generally know how to change practices on the ground. Developing practical tools (e.g., the HCVF toolkit) was generally agreed to be an important method for changing practices. We also do not know the relative effectiveness of these different methods for maintain/restoring biodiversity.

Possible BorNet research questions

- We need to examine regulatory and legislative barriers to maintaining biodiversity around the boreal, and use this document to inform policy-makers. What constraints are there in the boreal to the protection of biodiversity (e.g., the tenure system in British Columbia, Canada)? What different approaches are being used around the boreal?
- What values should be managed for in the boreal globally, what determines them, and where are there concentrations of high values?
- Should conservation efforts be only in high conservation value forests or should they occur outside of these too? We could examine this question through a two step process: first, use habitat requirements of focal species; second, use maps of HCVF in a micro-scale.
- How do we maintain ecosystem function? What should be measured? How do we maintain ecological function across scales?
- Within the TRIAD approach, how do we manage biodiversity in the "extensively managed" portion of our forested land base?
- We also need to promote interdisciplinary studies for places where a lot of the land is privately owned (i.e., Sweden). Education and public values are integral to any conservation effort, especially in countries where a lot of harvesting is on private land.
- After listing these research ideas, this breakout group further narrowed possible tasks for BorNet to the following three questions:
- What values should be managed for in the boreal globally, what determines them, and where are there concentrations of high values?
- How do we maintain ecosystem function? What should be measured?
- How do the different governance structures meet the three pillars of sustainability?

Appendix 2: Poster abstracts

"How much is enough?": A framework for risk assessment at multiple scales

Rachel F. Holt, Veridian Ecological Research Ltd., WWF Canada

ABSTRACT: Much scientific progress has been made in the process of defining what constitutes sustainable, or eco-certifiable, forest management. Methodologies for choosing appropriate criteria and indicators have been developed worldwide and incorporated into certification checklists. However, to date the question of "how much is enough" has been poorly addressed from a scientific perspective. This key "how much is enough" debate must be rephrased to separate its scientific and social aspects: scientifically we can assess the risks to ecological values associated with a particular management approach; social venues must then determine the "acceptability" of that risk.

Here, I present a general methodology for assessing the risks to ecological values at multiple organisational scales. The methodology consists of four main components: a) identify the appropriate scale for analysis, b) define the ecological benchmark against which comparisons will be made, c) set risk classes and look for potential thresholds, and d) report out on cumulative risk. Two examples will demonstrate key facets of the methodology. Example 1 presents a general framework for identifying: a) an ecological benchmark at indicator scales from coarse to fine filter, and b) the relative susceptibility to risk of indicators at multiple scales (since actual thresholds and risk classes are and will continue to be difficult to identify). The approach uses ecological parameters (e.g., life-history traits, ecosystem fragility, etc.) to identify systems/species more or less susceptible to risks. This framework provides guidance to managers, certifiers, etc. of ecological parameters to be aware of when assessing ecological risk. Example 2 is an applied example of the methodology; it presents results from a coarse-scale analysis of risks to ecosystems associated with rates of harvest over the next 250 years for an area of 5 million ha in northern B.C. The area encompasses ecosystems that range from wet interior cedar hemlock forests (the interior temperate rainforest) to extensive areas of sub-boreal spruce forest. Natural disturbance ecology is used to set ecological benchmarks; the approach demonstrates the implications to ecosystem risk susceptibility, based on variation in natural disturbance processes within these ecosystems. In summary, key components of a methodology for determining risk with or without concrete thresholds is presented.

Strategic planning of green infrastructures for the maintenance of forest biodiversity: A case study from central Sweden

Gregorz Mikusinski, Grimso Wildlife Research Station; Per Angelstam, Grimso Wildlife Research Station; and Peter Jaxgard, Department of Natural Sciences, Centre for Landscape Ecology

ABSTRACT: One of the main goals of Swedish environmental policy is the maintenance of biodiversity. For forest environments, forest policy states that naturally occurring populations should be maintained in viable populations. Largely due to a long history of forest management with insufficient considerations to the maintenance of representative forest types, functioning habitat networks are not available for many specialised species. To maintain viable populations of such habitat specialists, one solution is to create reserves for various forest types, the structure and dynamics of which is incompatible with the managed forest. In Sweden, attempts have been made to estimate the need for such forest reserves. The conclusions were that, depending on the forest region, there is a need to set aside existing forests with natural properties, as well as to start a restoration of the qualities in existing forests and even to re-create new forests on suitable land not forested anymore. However, for the practical implementation of these plans there is a need to make gap analyses of the amount needed to maintain naturally occurring species also at a regional scale in relation to the specific conditions found in, for example, different natural regions. Additionally, to secure a favourable conservation status and function of the resulting network of forest reserves, spatially explicit techniques should be developed to aid decision-making processes for the incorporation of new objects into the representative reserve networks of different forest types. Here, we present approaches for both regional gap analysis and strategic planning for the maintenance of forest biodiversity in the counties Dalarna and Gävleborg (33470 sq. km corresponding to 15 per cent of Sweden's forest area). The repeated mapping of landscapes by remote sensing during about two decades provides opportunities for analyses of the connectivity and representativity of habitat networks, as well as of the trends in the amount of different land cover types overtime. We focus on the gaps in the amount of forest habitat that has been estimated to be needed to maintain viable populations of the naturally occurring species.

This study has two main objectives.

1. To make a numerical estimate of the regional gaps of the amount of protected forest with high conservation value with respect to four forest types identified as being of high conservation value (old spruce, old pine, wet, old deciduous). The work contains three main steps:

   a) estimate the amount of potential forest vegetation of the four forest types based on modelling of the natural distribution of different forest disturbance regimes, and models of the age distribution of forest successions on mesic sites exposed to stand-replacing disturbance;

   b) estimate today's amount of the four forest types of conservation value using remote sensing data; and

   c) estimate the numerical gaps in the amount of forest needed to maintain viable populations of the most demanding species. The losses will be divided into loss of forest cover as well as the loss of the four focal forest types on today's forestland.

2. Present an approach for strategic and cost-efficient acquisition of forest areas which are incompatible with forest management using the principles of representativity and connectivity applied to the most demanding specialised species for the establishment of functional networks of conservation areas. Under this heading falls also the analyses of the representativity of different forest types within the existing reserve network.

The measurement of components of mountain forest biodiversity along a land use history gradient at the stand scale

Monika Breuss, University of Agricultural Sciences, Department of Wildlife Biology and Game Management, Austria and Per Angelstam, Swedish University of Agricultural Sciences, Grimso Wildlife Research Station, Sweden

ABSTRACT: Today, it is widely accepted that forests should be managed in an ecologically sustainable way, meaning that wood production, non-timber values as well as biodiversity are included. The 1992 Convention on Biological Diversity has not only focused international attention on the concept of biodiversity, but has also set expectations that the signatory nations will establish objectives for local implementation. Here, we focus on the measurement of biodiversity within a local landscape, such as within a forest management unit, a village or a water catchment.

A comprehensive system of biodiversity measurements should include a representative selection of all components of biodiversity for different forest ecosystems, be affordable to use in practical management and possible to be compared with agreed goals. However, the biodiversity concept is complex, and Europe's forest ecosystems have different natural and anthropogenic disturbance regimes including different successional stages. From a historical perspective, European forests differ considerably in the degree of loss and alteration. For both Mediterranean and lowland temperate deciduous forests, very few reference areas exist that define the natural dynamic. Instead, these forests form a complex of old and more or less intensively managed cultural landscapes. In comparison, the natural disturbance regimes of boreal and mountain forests of Europe are much better understood.

Here, we present the results of a study conducted in Montafon, W. Austria. The study area is only one out of six reference areas that have been selected for application of a biodiversity measurement system at the stand scale. In the methodology, we used robust variables describing different components of biodiversity (species composition, habitat structures, processes/functions) (see table below) that can be understood and collected in the field with standardised methods that require a minimum of training.

Spatial scale Components	Trees/patch	Stand
Species composition	• Wood-decaying fungi. • Saproxylic insects.	• Epiphytic, pendant lichens. • Vascular plants. • Woodpecker species. • Tree species.
Habitat structure	• Dead wood of different decay stages and diameter classes. • Large trees, hollow trees.	• Tree species composition. • Vertical layering. • Quality and quantity of dead wood.
Processes/function	• Uprooted trees. • Primary nest excavation.	• Browsing, grazing, fire, wind, snow, land abandonment.

Field data were collected using a stratified sampling design representing different landscape types (according to the land-use historical gradient in the study area) with randomly located clusters of systematically distributed sampling points within the case study. In summer 2001 we collected and analysed data from 352 sampling points.

The analyses of the results show that the position in the local and/or regional historical land use gradients has a great impact on the current status of biological diversity. Overall, the occurrence of specialist species (e.g., woodpeckers, pendant lichens), the amount of dead wood (e.g., snags, logs, stumps), large and special trees, as well as the presence of natural processes (e.g., wood-decaying fungi) decrease with an increasing intensity of past and ongoing land-use in the study areas.

However, to maintain viable populations of all naturally occurring species, the efforts to maintain forest components at the stand scale need to be aggregated at the landscape and perhaps even the regional scales. Only in this way can a representative and sufficiently dense network of different forest types at different spatial scales be maintained. Hence, in addition to the stand scale measurements, we need to develop measurements at the scale of the whole forest management unit.

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Alpine landscape similar to the Montafon area of Austria. Engadine, Switzerland. JOHN INNES PHOTO

Geographical Information Systems and remote sensing as support tools for boreal conservation in central Alberta

Jason Young, Earth Observation Systems Laboratory; Arturo Sanchez-Azofeifa, Earth Observation Systems Laboratory; and Olaf Jensen, Elk Island National Park

ABSTRACT: The issue of land-use and land-cover change (LUCC) has a significant impact on global environmental change. In the boreal ecosystem, increasing forestry, agriculture, and resource exploration are causing fragmentation and isolation of forest patches, which will affect the natural biotic and abiotic patterns. Elk Island Park represents aspen parkland, the southern limit of the boreal forests. Land-use changes in the region over the last several decades – due to agriculture and other factors – are isolating the park. The objectives of this study are to assess current land-cover of the Beaver Hills/Cooking Lake region and to quantify the rate and extent of land-cover change in the region as tools for the identification of key areas for conservation management. Land-cover and change maps will be created by analysis of Landsat satellite images from 1977 to 2000. Areas of high conservation value are located by integration of remote sensing land-cover data with other data sources such as location of endangered species. The project is in cooperation with Parks Canada, as part of the Beaver Hills/Cooking Lake Stewardship Initiative to promote conservation in the Beaver Hills region of central Alberta.

Recreating the boreal forest at Glenmore, Scotland, by removing exotic conifers and encouraging Scots pine.
JOHN INNES PHOTO

Adaptive management to sustain biological diversity on the Weyerhaeuser coastal tenure, British Columbia, Canada

Isabelle Houde, University of British Columbia, Canada

Context

Weyerhaeuser has embarked on a forest project on its coastal tenure in British Columbia. The project zones the tenure into three intensities of timber harvest and employs variable retention (VR) harvesting that retains patches or individual trees during harvesting. VR is applied in all zones: the old growth zone (10 per cent of the tenure, high (e.g., 70 per cent) retention, harvesting only on one-third of the zone); the habitat zone (25 per cent of the tenure and retention levels 20 to 25 per cent); and the timber zone (65 per cent of the tenure, 15 to 20 per cent retention). The approach is intended to maintain biological richness while allowing economically viable timber harvesting. An adaptive management approach is used to assess the forest project's effectiveness.

Criteria

Criteria are used to define the values provided by the sustainable forest management plan. We focus on the criterion related to ecological value: Biological diversity (biological richness and its associated values) is sustained within the Weyerhaeuser coastal tenure in British Columbia.

Indicators

Indicators are used to assess the success in attaining the criterion.

Indicator 1: Ecologically distinct ecosystem types are represented in the non-harvestable land base of the Weyerhaeuser coastal tenure to maintain lesser known species and ecological functions. Indicator 1 is intended primarily to ensure that little known species and functions that may not be assessed by indicators 2 and 3 are sustained. It also serves to identify unmanaged "benchmarks."

Indicator 2: The amount, distribution, and heterogeneity of habitat and landscape structures important to sustain biological richness are maintained over time. Indicator 2 evaluates habitat elements and structures we know are required by many species, and projects consequences of changes in those habitat elements through time.

Indicator 3: Productive populations of species are well distributed within Weyerhaeuser's coastal tenure. Indicator 3 assesses whether species naturally present on Weyerhaeuser's coastal tenure are likely to continue as well-distributed, productive populations. It serves as a test of the broader approaches of indicators 1 and 2.

Adaptive management program: Evaluating success

Efforts to attain and evaluate success proceed best through the framework of adaptive management. For adaptive management to attain its theoretical promise, it must contain four broad elements.

- Clearly defined objectives: Objectives, or criteria of success, must be sufficiently clear that means of assessing proximity to objectives are likewise clear.
- Planning and practices to attain the objectives: Hierarchical planning can reduce the amount of planning required at the operational level by addressing some issues at the strategic or tactical levels (e.g., planning for the sustained provision of dead wood often proceeds best over tactical units, but has implications at the operational scale of individual stands).

- Ways to assess proximity to those objectives: The objective of sustaining biological richness must be evaluated for the entire tenure rather than to specific cutblocks. Assessments cannot occur everywhere, so they must be designed in a fashion that can be "scaled up" to apply to larger areas, and assessing proximity to an objective or its component features should be assessed by prediction. Prediction is not consistently possible. For large groups of organisms (e.g., invertebrates and fungi) we know too little to make useful predictions for more than a very small portion of the group. Effectiveness monitoring includes both active and passive adaptive management. ("Active adaptive management" refers to experiments specifically designed to better inform forest practices. "Passive adaptive management" indicates only the absence of a designed experiment, and includes retrospective sampling or computer simulation.)
- Ways to modify practices if objectives are not attained (links to management action): The evaluation system should assess the success of current management activities and track improvements in management through time (e.g., develop a scientifically-based scoring procedure providing scores for specific habitat elements, model species or "guilds" of vertebrates, other organisms, or landscape pattern). The evaluation system should employ a wide range of monitoring approaches that can be collected into two broad groups: implementation monitoring and effectiveness monitoring.

Closing the loop

In this example we use old growth forest, associated structural components, and associated focal species.

Indicator 1: Ecological representation (amount and location of old growth stewardship zones)

- Areas that contain higher amounts of poorly represented ecosystem types should be favoured for location of old growth zones or direct the location of mini-zones.
- The representation analysis shows that the drier warmer variants have fewer unmanaged areas than other variants, and the higher elevation variant, the MH, has a large proportion unmanaged.

Results suggest…

- Locations of zones should be adjusted to include more old growth, restoration, or habitat zones in the warmer, drier variants (CDF and CWHxm), and areas of old growth should be preserved or restored in these drier variants.
- Monitoring of structures and species should be careful to include the drier variants.

Indicator 2: Habitat structure (old growth structure)

- Large trees (especially large Douglas-fir) and large snags had higher retention levels in dispersed VR.
- Dispersed VR retained substantially lower levels of many habitat elements than group VR. Total snag retention was particularly low in dispersed VR.

Results suggest…

- The need for the whole range of habitat elements suggests not neglecting dispersed VR but putting most emphasis on mixed and group VR. Since mixed VR tended to have additional retention in the matrix, it should be favoured over group VR.

Indicator 3: Focal species used as indicator organisms should...

- Be likely to provide useful information under a wide range of forest management options;
- Reflect the *range* of real organisms (e.g., poor dispersers, cavity users, shrub nesters…);
- Allow us to report on landscapes in a way that combines the effects of management options at a number of scales and is biologically meaningful; and
- Be from easily sampled groups (e.g., breeding birds, calling amphibians, and plants).
- Indices known to influence species were monitored for various patterns of retention (e.g., species' responses to stand-level practices, time to "recovery" of suitable habitat in managed stands, and organisms' abilities to move through non-suitable habitat, and their movement distances).

Red-Legged Frog (*Rana aurora*)

- The probability that a frog would leave a tree patch increased with decrease in patch size, and patches with streams were more likely to have frogs remain in them.

Western White Trillium (*Trillium ovatum*)

- Western White Trillium, a sensitive vascular plant, was found significantly more often in patches than in dispersed variable retention.

Other organisms

- Few carabid species were more abundant in old growth patches than in dispersed variable retention.
- Two gastropod species were found only in controls, several species re-colonized matrix within two years of harvest, suggesting that they moved underground while habitat was inadequate.
- Mycorrhizae were found to decrease significantly within the first 15 m from the edge of patches.
- Mixed variable retention was better that either patch or dispersed variable retention at maintaining bird communities.

Results suggest…

- Trends of abundance of organisms in different types of variable retention and around edges (e.g., mycorrhizal fungi) can help design patterns of retention within blocks.
- Management actions could include favouring larger retention patches or changing patterns of harvested blocks on the landscape to retain larger patches of forest.
- Focus on a modelling effort to help define relationships and allow modelling over long timeframes and large areas.
- Focus on further finer-scale monitoring for some species that may indicate productivity.

Contributing researchers: F.L. Bunnell, W. Campbell, A. Chan-McLeod, G. Dunsworth, D. Huggard, L. Kremsater, H. Kope, I.A. Pearsall, M.I. Preston, R. Outerbridge, K. Ovaska, L. Sopuck, J.A. Trofymow, and others.

Overview of FORREX – Forest Research Extension Partnership, Canada

Susan Leech, FORREX Canada

ABSTRACT: This poster provides an overview of the mandate of FORREX – Forest Research Extension Partnership, a Canada-based organization whose goal is to provide extension services in natural resource management. Extension involves facilitating and improving the link between researchers, practitioners and policy-makers, and is particularly important in applied scientific fields such as forestry and conservation. The Forest Research Extension Partnership is helping to improve communication between different organizations and groups involved in natural resource management and conservation, through identifying knowledge gaps in our understanding of natural resource management, providing extension services (using synthesis papers, workshops, field tours, and other technology transfer tools), and making existing information more accessible through information management. The poster highlights some of the Forest Research Extension Partnership's ongoing projects and tools to help improve communication within natural resource management and conservation.

High Conservation Value Forests: An assessment of forest condition

Tony Iacobelli, WWF Canada, and Rachel Holt, Veridian Ecological Research Ltd., WWF Canada

ABSTRACT: Conservation and management decision-makers worldwide are grappling with applying a burgeoning number of concepts aptly described by the Forest Stewardship Council "High Conservation Value Forests." Before these concepts can be applied to purchasing agreements, or management approaches, these forests need to be identified on maps. This pilot aims to identify a subset of HCV forests – those described as "large landscape level forests," for two ecosections in B.C. The project will be based on an assessment of current condition of forest types within this landscape using 1:20,000 forest cover mapping. Current seral stage distribution will be compared with the predicted distribution based on projecting stand-replacing disturbance interval. Steps in the analysis of forest condition include:

- Estimate the "natural" amount of each seral stage (particularly "old" forests), based on natural disturbance patterns;
- Calculate current seral stage distributions from the forest cover data;
- Determine risk classes and thresholds based on deviation from the expected distribution. This should include consideration of the scale of the analysis, veracity of the data available, the natural variability of natural disturbance processes, the biological fragility, uniqueness and richness of the ecosystems under consideration and the regional and global context; and
- Modify risk classes and outcomes based on analysis of patch metrics (size, interior forest habitat etc.), road density information and other context data.

This pilot may not definitively identify HCV forests, but the outcome will be compared to the results of similar studies using proxy measures (e.g., road density data) carried out by other groups using different methodologies and at different spatial scales (e.g., Global Forest Watch's "intact forest" analyses). This comparison should illuminate the implications of using different approaches and different thresholds to define High Conservation Value Forests.

Appendix 3: Biographies of speakers and panel members

Per Angelstam, Department of Conservation Biology at the Swedish University of Agricultural Sciences, WWF and Department of Natural Sciences at Örebro University, Sweden

Per Angelstam's research interests lie in the fields of landscape ecology, studies on the consequences of forest fragmentation on wildlife, and conservation biology with work on biodiversity maintenance and forest landscape management. Since 1990, Per Angelstam has been using the steep north European forest and land use history gradient from Scandinavia to Russia for studies of landscapes and their species composition. He is also involved in the European Union BEAR project. Finally, Per Angelstam is involved in the practical implementation of research by synthesizing existing knowledge, training forest and land use managers in ecological landscape planning, and educating students in landscape ecology.

Petri Ahlroth, Finnish Ministry of Agriculture and Forestry, Finland

Dr. Ahlroth is currently working at the Ministry of Agriculture and Forestry. His job is to compile research related to conservation of forest biodiversity and to write a draft of a new related research program. This work is supposed to focus the use of resources at the conclusion of the FIBRE program.

Stefan Bleckert, Sveaskog, Sweden

Bio not available

Stan Boutin, University of Alberta, Canada

Stan Boutin has 23 years experience in the field of ecology and environmental biology, with four years direct forestry experience while working for Alberta-Pacific Forest Industries Inc. as a Research Ecologist, Program Leader, and Director of Science and Technology. Recent research work has focused on integrated landscape management issues directly related to cumulative effects and the influence these effects have on Alberta's environmental and economic sustainability. Currently, he holds an NSERC Industrial Research Chair in the Faculty of Science at the University of Alberta. He is also a Research Area Leader for the Sustainable Forest Management Network, one of Canada's Networks of Centres of Excellence. Stan Boutin has authored over 80 refereed publications and 12 book chapters. He also co-edited "Ecosystem Dynamics of the Boreal Forest: The Kluane Project," a book that summarizes a large-scale terrestrial research project in the boreal forest of the Yukon. Stan Boutin was co-winner of the Publication of the Year award in 1995 from the Wildlife Society for his collaborative work on a 10-year project designed to test hypotheses relating to the organization of the boreal forest vertebrate community. Finally, Dr. Boutin is also the Associate Editor of the Journal of Wildlife Management.

Hans Djurberg, Environmental Coordinator, IKEA

Hans joined IKEA in January 2001 as Environmental Coordinator for IKEA Trading Americas. He is responsible for the IKEA Forestry Action Plan implementation at IKEA suppliers in North and South America and works as lead auditor for ensuring supplier compliance with the IKEA Code of Conduct concerning Outside Environment, Working and Social Conditions and Forestry. Hans has a background in the Swedish forest products industry with experience working with Environment Management Systems, certification and Total Quality Management. He has an M.Sc. in Forestry from the Swedish University of Agricultural Sciences. Hans has previous experience working with the Swedish Forestry Association, Stockholm, Sweden. Project Manager (1996-1997); SCA Forest and Timber AB, Sundsvall, Sweden. Environmental Management Coordinator (1997-1998); SCA Forest and Timber, Sundsvall, Sweden. Project Manager Planning Systems (1998-1999); SCA Forest Products, Sundsvall, Sweden. Head of R&D (Forestry) (2000).

Pierre Drapeau, Department of Biological Sciences, University of Quebec at Montreal, Canada

Pierre Drapeau is an Adjunct Professor in Biology at the University of Quebec at Montreal. He is also a member of the research team of the Canada Industrial Chair in Sustainable Forest Management (SFM) of University of Quebec at Abitibi-Témiscamingue (UQAT) and University of Quebec at Montreal (UQAM). He received a PhD in Biology at the University of Quebec at Montreal under the supervision of Dr. Raymond McNeil. His research focuses on the effects of landscape-scale changes in the forest cover (from both natural and human origin) on various taxa in the boreal mixedwood and black spruce forests of eastern Canada (Quebec and Ontario).

Jean Paul Gladu, Aboriginal Forest Research Coordinator, National Aboriginal Forestry Association and Sustainable Forest Management Network, Canada

As a member of Sand Point First Nation, Jean Paul started down the forestry path, attending Sault College of Applied Arts and Technology and working the summers at Sleeping Giant Provincial Park. After graduating in 1993 from the Forestry Technician Program, he took a post with the Canadian Forest Service as a Silviculture Technician under the Reserve Lands Forestry Program Ontario. In the fall of 1996, he accepted a position with the Ministry of Forests in British Columbia as an Aboriginal Forestry Advisor. From 1997 through 1999, Jean Paul worked for the private sector in B.C. as a harvesting and road layout technician, ungulate surveyor and as a First Nation Program Manager. Jean Paul returned to school in the fall of 1998 at Northern Arizona University. The Native American Forestry Program (BSF) has helped prepare him for a position as a Policy Forester with the National Aboriginal Forestry Association, which began in January of 2000. Jean Paul has been involved in a number of national issues including the National Forest Strategy, Criteria and Indicators of Sustainable Forest Management in Canada, and the First Nation Forestry Program. He has also co-authored a discussion paper entitled "First Nations Governance and Forest Management" and was the lead author on a discussion paper entitled "Parks, Protected Areas and Aboriginal Communities." Jean Paul now holds the research portfolio at NAFA. In addition to his current duties, he accepted a half time position as the Aboriginal Forest Research Coordinator with the Sustainable Forest Management Network (SFMN) in May 2002.

Russell Graham, USDA Forest Service, Rocky Mountain Research Station, United States

Russell Graham has over 27 years of research experience in the Rocky Mountains with the Rocky Mountain Research Station, USDA Forest Service. After receiving a B.S. in forestry in 1972 at the University of Montana, he started his professional career as a Forester, for the Bitterroot National Forest. In 1975, he transferred to the Research Station and completed an M.S. in silviculture in 1976 and a PhD in silviculture in 1981, both at the University of Idaho. His principle research involves long-term forest productivity and landscape processes, including a major study on forest structure and its impact on wildfire severity and intensity, and productivity research concentrated on the management of forest organic materials, primarily coarse woody debris and the material stored on the forest floor. In addition, Russ has been heavily involved with the management of the northern goshawk and involved with landscape level ecosystem projects throughout the central and western United States. He was the Deputy Science Team Leader for the Interior Columbia Basin Ecosystem Management Project and is presently the Leader of the Science Advisory Group for the project. Most importantly, Russ is a Research Silviculturist concentrating on providing information for the management of Rocky Mountain forests to meet a wide variety of management objectives.

Jan-Erik Hällgren, Dean of Forestry at the Swedish University of Agricultural Sciences, Sweden

Bio not available.

Daryll Hebert, Encompass Strategic Resources Limited, Canada

Bio not available.

Rachel Holt, WWF Canada, Veridian Consulting Ltd., Nelson, British Columbia, Canada

Rachel Holt is a consultant applying ecological theory to forest management issues in B.C., both within the provincial legislative framework, and in application to forest stewardship certification. Her work involves applying natural disturbance ecology to ecological risk assessments in a number of ecosystems around the province – to determine the implications of "how much is enough" decisions. Dr. Holt has also been involved in the development of a provincial strategy to improve decision-making around forest management practices using habitat supply modelling. From this work, broad frameworks for improving ecological risk assessment procedures relevant to a wide variety of ecosystems are being developed.

John Innes, FRBC Chair of Forest Management, Faculty of Forestry, University of British Columbia, Canada

John Innes holds the FRBC Chair of Forest Management in the Faculty of Forestry at the University of British Columbia. His research interests are centred on the assessment of sustainable forest management practices, particularly long-term monitoring of the impacts of forestry activities. Recently, he has been working on the use of terms such as "endangered forests," "frontier forests" and "old-growth forests," particularly in relation to the application of these to northern forests. John is the Principle Investigator for the Canadian BorNet project in collaboration with the other Canadian Steering Committee members.

Steve Jennings, ProForest, United Kingdom

Bio not available.

Stig Larsson, Department of Entomology, the Swedish University of Agricultural Sciences (SLU), Sweden

Stig Larsson's research focuses on two areas: the management of biodiversity in boreal forests, and the ecology of plant/herbivore interactions. Currently, he directs a research program aimed at determining to what extent the "new forestry" actually contributes to maintaining biodiversity. In particular, this research strives to understand whether the current practice in Swedish forestry of retaining coarse woody debris reduces the risk of local extinction of red-listed wood-living insects. Dr. Larsson's research on plant/herbivore interactions is primarily focused on variation in plant resistance to insects, in particular the role of environmental modification of genetically determined resistance.

Susan Leech, FORREX – Forest Research Extension Partnership, British Columbia, Canada

Susan is a registered professional biologist with a background in research, education, wildlife monitoring and conservation biology. From her previous position as the Research Coordinator at the University of British Columbia Research Forests, she has hands-on experience in forest management within the context of local communities, and an ability to balance the values and needs of different groups across the landscape. Susan's current position focuses on fostering communication between all facets of the natural resource management community to improve biodiversity management within forested landscapes.

Luigi Morgantini, Chief Biologist and Forest Ecologist Coordinator, Weyerhaeuser Company, Alberta, Canada

Luigi is the Chief Biologist and Forest Ecologist Coordinator for Weyerhaeuser Company in Alberta. Since 1988, he has been an Adjunct Professor in the Department of Renewable Resources at the University of Alberta, where he also teaches a course on the impact and mitigation of human activities on wildlife. Luigi holds a Doctor of Science degree from the University of Rome (Italy), and an M.Sc. and PhD in Wildlife Productivity and Management from the University of Alberta. Luigi has worked in wildlife conservation and management for over 30 years, initially with the World Wildlife Fund in Italy. During the last 26 years, he pursued research with the University of Alberta, and for various government agencies and private companies in Alberta and the Unites States. Luigi's main research interests focus on wildlife ecology and behaviour, on the impact and mitigation of land use practices on wildlife, and on the integration of wildlife habitat requirements in forest management. In 2001, Dr. Morgantini was awarded the Wildlife Habitat Canada Forest Stewardship Award for his leadership in caribou conservation in Alberta and, in 2002, the Alberta Emerald Award for life-long environmental stewardship.

Jari Niemelä, Department of Ecology and Systematics, University of Helsinki, Finland

Jari Niemelä is the head of the Department of Ecology and Systematics at the University of Helsinki in Finland. His main research fields include forest biodiversity, conservation biology and urban ecology. He has published more than 80 scientific papers, and is member of the Editorial Board of Biodiversity and Conservation. He is currently leading two national research projects: the effect of the size of retention tree groups on biodiversity in forest regeneration (RETREE); and ecology and urban planning (ECOPLAN). Furthermore, Dr. Niemelä leads a global network for assessing biodiversity changes across urban-rural gradients (GLOBENET). He is also member of the steering group of the Finnish project Application of Biodiversity Research. Dr. Niemelä is a partner in three EU projects: BioAssess; Development of Urban Greenspaces to Improve the Quality of Life in Cities and Urban Regions (URGE); and European Biodiversity Forum – Implementing the Ecosystem Approach (Bioforum).

Suvi Raivio, Biodiversity Specialist, Finnish Forest Industries Federation, Finland

Suvi Raivio is currently working as Biodiversity Specialist in the Finnish Forest Industries Federation (FFIF), an interest organisation for the Finnish wood-processing industry. Her work includes several aspects of forest environment, ranging from threatened species, forest conservation and management practices to landscape ecological planning, climate change and forest policy. The largest part of her work is representing FFIF in several working groups and committees, including the steering committee of FIBRE, but she also tries to keep track of what is going on in research. Suvi's background is in animal ecology with a PhD from the University of Helsinki on the effects of forest fragmentation on birds. Since then she has worked for the Finnish Forest and Park Service and the Finnish Environment Institute as a senior research scientist on projects studying the effects of forest management practices on biodiversity and landscape ecological planning.

Lauri Saaristo, University of Helsinki, Finland

Lauri Saaristo is currently working at the University of Helsinki. He is a researcher in the BITUMI-project (Applicability of biodiversity research 2000-2002). His job is to organize activities that enhance communication and interaction between forest managers and researchers.

Marc Stevenson, Sustainable Forest Management Network, Alberta, Canada

Dr. Marc G. Stevenson is the Aboriginal Program Manager for the Sustainable Forest Management Network. Marc has for over 20 years of professional experience with Aboriginal social, economic, cultural, ecological and political issues. He has consulted for many Aboriginal organizations as well as government, NGOs and industry on a broad range of issues affecting Aboriginal communities across Canada. These experiences, combined with a Ph.D in applied anthropology, have allowed Marc to address, in an innovative manner, many of the environmental, social, political, economic and cultural issues facing Canada's First Nations', Inuit and Metis peoples. In particular, Marc has developed considerable expertise in indigenous knowledge and management systems, co-management, and sustainable development. Marc remains committed to balancing government's and industry's needs with those of Aboriginal peoples, and to fostering opportunities for Aboriginal communities to facilitate their own social, economic, and political development. Marc is an associate of the Canadian Circumpolar Institute, an adjunct professor at the Department of Anthropology (pending), a former director of the Independent Environmental Monitoring Agency for the BHP Diamond Mine, Northwest Territories, and the author and co-author of many publications and reports on Aboriginal issues.

John Spence, Department of Renewable Resources, University of Alberta, Edmonton, Canada

John Spence is currently the Chair of the Department of Renewable Resources at the University of Alberta. His research encompasses three general areas bridging evolution and ecology: structure and dynamics of arthropod populations; integration of communities, especially those under anthropogenic influence; and the nature and evolution of arthropod species and their life histories. Issues in these foci are richly interconnected and Dr. Spence believes that a synthetic approach is central for full understanding of biological issues and for rational management of sustainable ecosystems. Thus, the research program in his lab couples broad scientific objectives with the promise of shorter-term applications in management and conservation of forests and wetlands. Work generally proceeds from a strong natural history base to develop experimental approaches to questions that apply to particular taxa. Generalization follows after common threads are discovered and confirmed experimentally.

Bjørn Åge Tømmerås, Research Director, Division of Conservation Biology, Norwegian Institute for Nature Research (NINA), Norway

Bjørn Åge Tømmerås is focused on research and management concerning forestry, forest ecology and biodiversity and the impacts of the driving forces and activities on forests. His qualifications range from emphasizing ecology at the stand level, to landscape and ecosystem level and ultimately to the national, European and international levels on overall forest policy, management and scientific evaluation. His interests also include biodiversity, structure and processes in forest ecosystems with an emphasis on insects and host trees. His work has lead to: the development of indicators on and monitoring of biodiversity; the development of conservation biology criteria for conservation status of insects and evaluation and documentation of Red Data list; and follow-up on the Convention on Biological Diversity for use and conservation of biological resources.

Ola Ullsten

Mr. Ullsten holds a Bachelor of Arts in Social Science, University of Stockholm ("Socialinstitutet"), Sweden, and an Honorary Degree of Doctor of Laws Honoris Causa at the University of Guelph, Canada. He has held a range of elected offices and political appointments including: Member of the Swedish Parliament (Stockholm) 1964-1983; Leader of the Swedish Liberal Party 1978-83; Minister for International Development Co-operation 1976-78; Minister of Immigration 1977-78; Prime Minister 1978-79; and Minister of Foreign Affairs (with International Development Co-operation) 1979-83. More recently, Mr. Ullsten has held the diplomatic posts of Ambassador to Canada 1983-89 and to Italy 1989-96. Mr. Ullsten is involved as Chairman of a working group on "Global Deforestation Trends" appointed by the InterAction Council 1987; Co-chairman of "The European Forum for Forest Protection" 1988-1990; Chairman of a review team on the "Tropical Forest Action Plan" appointed by FAO 1990; and Co-chairman of the independent "World Commission on Forests and Sustainable Development" since 1995. Other roles that Mr. Ullsten plays are as member of the "InterAction Council" which is a think tank of some 30 former heads of government and state, 1983-1999; Member of the Board of Directors of the Woods Hole Research Center, Woods Hole, Massachusetts, USA since 1999; and Senior Fellow at the International Institute for Sustainable Development, Winnipeg, Canada since 2000.

Marc-André Villard, Department of Biological Sciences, University of Moncton, New Brunswick, Canada

Marc-André Villard is an Associate Professor in Biology and holds the Canada Research Chair in Landscape Conservation at the University of Moncton. He received a PhD in Biology at Carleton University under the supervision of Dr. Gray Merriam. His research focuses on the effects of forest loss and fragmentation on various taxa in the Acadian forest of New Brunswick, the boreal mixedwood forest of Alberta, and the northern hardwoods forest of Quebec and Ontario.

Jan Volney, Canadian Forest Service – Northwest Region, Alberta, Canada

Jan Volney is a Research Scientist with the Canadian Forest Service whose work aims to understand the changing impacts of insects on forest productivity. He earned degrees in forest entomology (BScF, University of New Brunswick, forest ecology (MFS, Yale University), mathematics and statistics (MA, UNB) and forest entomology (PhD, State University of New York, College of Environmental Science and Forestry at Syracuse). Prior to joining the Canadian Forest Service in 1985, he taught Forest Entomology and Insect Natural History at the University of California, Berkeley. He is also an Adjunct Professor in the Departments of Biological Sciences and Renewable Resources at the University of Alberta, Chair of the Forest Science and Technology Board of the Canadian Institute of Forestry, and Co-Editor of the Canadian Journal of Forest Research.

Allan Watt, Centre for Ecology and Hydrology, Banchory Research Station, Scotland

Allan Watt joined CEH Banchory in 1999, taking up the posts of leader of the Population Ecology Section and Deputy Director of Site. His research interests focus on two areas: science underpinning the conservation of biodiversity, principally but not exclusively forest biodiversity; and the management of forest pests. He is currently involved in three European (EU-funded) projects on biodiversity and has previously worked on biodiversity in both European and tropical forests. Dr. Watt is particularly interested in developing methods for monitoring biodiversity (indicators and rapid biodiversity assessment) and in quantifying the impact of land use change on biodiversity e.g., forest clearance and conversion to plantation. He also currently works on the pine beauty moth, the most serious pest of established forests in the UK, and has previously worked on pests such as the mahogany shoot borer. Dr. Watt is currently the co-editor of Agricultural and Forest Entomology.

Carolyn Whittaker, BorNet Coordinator, University of British Columbia, Canada

Over the past decade while working in resource management as a researcher and consultant, Carolyn Whittaker has had first hand experience in landscape ecology, wildlife management, conservation, and environmental policy in Canada and the Unites States; tropical forest conservations in Sierra Leone, W. Africa; and boreal forest ecology in circumpolar boreal countries. Carolyn is currently employed as a Research Manager at the University of British Columbia coordinating BorNet. Prior to working at UBC, Carolyn compiled a research synthesis of work relating to the sustainability of the boreal forest for the National Centres of Excellence – Sustainable Forest Management Network, part of a successful application for renewal of the network's funding (approximately $49 million over seven years), completed while Carolyn worked with the University of Alberta as Research Integration Coordinator. This role built on Carolyn's previous experience working at Rutgers University in New Jersey as Manager of the New Jersey Center for Environmental Indicators (NJCEI) coordinating scientific input into state environmental policy. At NJCEI, she also led a research project on community based environmental processes examining capacity and resources of communities in New Jersey to develop and use indicators for monitoring environmental quality, prepared for the New Jersey Department of Environmental Protection and the Center for Environmental Indicators.

Alexey Yarshenko, Greenpeace Russia

Bio not available.

Appendix 4: Contact information for workshop participants

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BORNET PROJECT OVERVIEW

PHASE 1
NATIONAL SYNTHESIS

Canada: Three BorNet regional workshops

Finland: FIBRE program

Sweden: MISTRA program

Funding – Canada: SFMN;
Sweden: MISTRA, Finland: FIBRE

PHASE 2
INTERNATIONAL PROGRAM

International conference May 2002

- Networking
- Development
- Knowledge gap analysis

Funding – Canada: NSERC IOF and SFMN;
Sweden: MISTRA; Finland: BITUMI

PHASE 3
INTERNATIONAL IMPLEMENTATION

Industry feedback
Project dissemination
New research opportunities

Funding to be sought –
Canada: SFMN, private sector