WWF-Canada
High Conservation Value Forest Support Document

DRAFT FOR REVIEW

November 2005

WWF-Canada
245 Eglinton Ave. E., Suite 410
Toronto, ON, M4P 3J1

Produced in collaboration with:

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

INTRODUCTION

ACKNOWLEDGEMENTS

This document is the result of a collaborative effort between the staff at World Wildlife Fund Canada and The Nature Conservancy.

We would like to acknowledge a wide range of forest and conservation practitioners that have written and/or reviewed HCVF assessments. We would also like to acknowledge the contributions from industry, ENGO's and various agencies through their participation in two FPAC/WWF workshops held in Edmonton and Toronto in May and June 2005.

In particular we would like to recognize the Ivey foundation and the Forest Products Association of Canada for supporting the continuing development of the High Conservation Value Forest approach.

We also acknowledge forest companies, government and other agencies that contributed data for use in this document, including:

- Abitibi Consolidated
- Tembec
- Vermillion Forest Management
- MNR Northeast Region
- NHIC
- Quebec CDC
- NRCan (CanFI).

INTRODUCTION

PREAMBLE

The High Conservation Value Forest concept is a recent creation of the Forest Stewardship Council (FSC), first published in 1999, and emerges from the scientific literature regarding systematic conservation planning. Although defined by FSC for use in forest management certification, it is increasingly being applied in other areas, such as landscape management and conservation planning, conservation advocacy, responsible purchasing, investment and donor policies.

There has been rapid uptake of the HCVF approach in Canada by forestry companies. We estimate that there are up to 20 HCVF reports written for forest tenures in Canada's commercial forest zone covering over 20 million hectares of public forestland. In the last 5 years, the HCVF approach has evolved from a concept to application with independent verification under a certification process. In that time, a global tool kit has been developed by ProForest to further define HCVFs (http://www.proforest.net/index3.htm) and a national framework has been written for Canada (http://www.fsccanada.org/policies/document.shtml; see Appendix 5 in the FSC Canada National Boreal Standard) to move towards standardizing the HCVF investigation.

This first generation phase of HCVF development and application in Canada has seen a steady improvement in the data analysis, investigation, delineation and description of management prescriptions for HCVFs. While there has been steady improvement, practitioners continue to struggle with some aspects of the HCVF application, such as the threshold when a value becomes a "high conservation value" and what proportion of the distribution of a value is the most "critical and/or outstanding". As a result, World Wildlife Fund (WWF), together with The Nature Conservancy (TNC) and other conservation partners, have prepared this support document in the spirit of providing assistance to forest and conservation practitioners for future application of the HCVF framework. While most of the existing HCVF reports and examples put forward in this document are drawn from the boreal, the guidance offered in this report is applicable to HCVF assessments throughout Canada.

This document has two main parts. An introductory section discusses overarching topics applicable to all or most of the HCVF assessment process. The remainder of the document is arranged by the 6 principal HCVF categories and 19 questions established in Appendix 5 of the FSC Canada National Boreal Standard; High Conservation Value Forest National Framework. Each section addresses one or more of the 19 questions and can be used as stand alone documents. Together, these sections can provide supplemental support to Appendix 5 for practitioners undertaking a full HCVF assessment.

WWF and TNC have focused here on those aspects of the HCVF framework most related to biodiversity conservation. HCV questions addressing vulnerable and irreplaceable elements and intact forests (HCV1 to HCV3) are discussed in more detail in the document than ecosystem services (HCV4). Furthermore, we have not provided examples of forest areas fundamental to meeting basic needs of local communities (HCV5) or forest areas critical to local communities' traditional cultural identify (HCV6). These issues require considerable consultation with communities in to order to generate HCVFs. WWF and TNC encourage organizations with expertise in these social and cultural issues to provide further guidance on HCV5 and HCV6.

INTRODUCTION

INTRODUCTION

What are High Conservation Value Forests?

High Conservation Value Forests (HCVFs) are defined by the Forest Stewardship Council as forests of outstanding and critical importance due to their high environmental, socio-economic, biodiversity or landscape values. HCVFs comprise the crucial forest areas and values that need to be maintained or enhanced in a landscape. HCVFs can be identified across broad forest biomes (tropical to boreal), within a wide range of forest conditions (largely intact to largely fragmented), and in ecoregions with complete or under-represented protected area networks. Principal 9 of the FSC Canada National Boreal Standard calls for the identification, management and monitoring of HCVFs.

High Conservation Value Forests may or may not be included in protected areas networks. Certainly, where HCVFs include under-represented features, then we suggest the HCVF should be evaluated for inclusion in a protected areas network. In practice, many HCVFs will continue to be managed outside protected areas and here approaches will vary (e.g. enhanced management or long-term "no-cut" reserves) but should always aim to maintain HCVF values. In regions where the forest is largely degraded, HCVF management should be consistent with a forest landscape restoration strategy that addresses ecological, social and economic objectives. Two principles are paramount: (1) HCVFs are managed to *maintain the attributes that are of high conservation value*, and (2) management employs the *precautionary principle*, which requires that where the effects of extraction and other management are unknown, values are insured through a cautious approach.

While we believe that there is a clear link between the assessment and identification of HCVFs and protected areas planning, this does not suggest that HCVFs are *de facto* protected areas. There are two general situations in which permanent protection emerges as the best management prescription for select HCVFs: (1) the intrinsic value or a confluence of values in a HCVF suggests that the attribute can only be maintained if industrial resource extraction is excluded, and (2) the HCVF is selected as a candidate protected area within a comprehensive and systematic conservation planning process.

What are the objectives of this document?

The main purpose of this support document is to assist future applications of the HCVF framework in Canada. This document emphasizes a systematic investigation and improving consistency of HCVF assessments with objectives to:

- Outline sequential steps for problem solving and information gathering for each of the principle conservation themes comprising an HCVF assessment;
- Provide further discussion related to the interpretation of HCVF thresholds;
- Improve consistency in the application of the HCVF framework by outlining well-documented, investigative techniques for HCVF assessments;
- Offer additional methods and/or analytical techniques to identify, map and assess the relevance of conservation attributes;
- Define the role of HCVF assessments within the larger context of conservation planning;

What is an HCVF assessment?

Within the FSC context, a HCVF assessment fulfills Criterion 9.1 (HCV identification). In this document, we use examples to emphasize a logical sequence of steps to complete an HCVF assessment. The ProForest HCVF Tool Kit (Part 3, 2003) provides a flow chart that likewise outlines these steps. For forest practitioners in Canada, the first step is to consult the HCV check list (Appendix 5 to the National Boreal Standard) to determine whether the conservation value potentially exists in the forest area. This will require that a thorough range of information sources be consulted, such as species at risk lists, range maps, ecosystem classifications and conservation status assessment, watershed management plans and other types of existing conservation evaluations.

The checklist (Table 1) provides a structure to investigate a range of conservation values, from species to community types and from point occurrences to landscapes, and apply the generic threshold to determine if the value is critical and/or outstanding at global, national or regional scales. In some cases, any occurrence or the entire distribution of a conservation value will be determined to be a high conservation value. In other cases, only a concentration or critical portion of the distribution of the conservation value will meet the critical and/or outstanding threshold. In all cases, and also when HCV status is not confirmed, a clear rationale should be provided for the decision.

If an attribute is confirmed as a HCV, the next step is to then delineate the HCVF at the appropriate stand to landscape scale. This is the forest area required to maintain or enhance the value. At the stand scale, this could be the distribution of site types with the potential to recover a declining tree species or ensure the potential for a particular seral stage. At the landscape scale, an entire watershed or the riparian buffers around all streams in a watershed may be delineated as a HCVF.

What are HCV thresholds?

The key decision point in an HCVF assessment for any conservation value is to determine when the value is of critical and/or outstanding importance. This threshold may be the entire distribution for a vulnerable or irreplaceable element, such as a particular species at risk or rare community type, or it may be a portion of a focal species' suitable habitat that is currently most limiting. Setting this threshold is rarely prescriptive since it relates very much to the current status, scale, future trends, and expected and observed distributions

Table 1: Simplified HCVF checklist

HCV Category 1 *Forest areas containing globally, nationally or regionally significant concentrations of biodiversity values.*	• Species at risk • Endemics • Wildlife concentration areas • Critical habitat for regionally significant species • Outlier or range edge species • Protected areas and candidates
HCV Category 2 *Forest areas containing globally, regionally or nationally significant large landscape level forests*	• Large landscape level forests
HCV Category 3 *Forest areas that are in or contain rare, threatened or endangered ecosystems*	• Naturally rare ecosystem types • Declining ecosystem types • Remaining intact forests (where large landscape level forests are rare or absent) • Unique and/or diverse ecosystem types
HCV Category 4 *Forest areas that provide basic services of nature in critical situations*	• Forests critical for drinking water quality • Erosion • Flooding • Fire barrier • Ameliorating microclimate for agriculture and fisheries
HCV Category 5 *Forest areas fundamental to meeting basic needs of local communities*	• Forest areas fundamental to meeting basic needs of local communities
HCV Category 6 *Forest areas critical to local communities' traditional cultural identity*	• Forest areas critical to local communities' traditional cultural identify

of each conservation attribute within the tenure and in comparison to the ecoregional context. The examples in this document, however, attempt to identify *a priori* thresholds primarily by considering the relation of the regional distribution to the occurrences in the tenure for select conservation attributes, as well as consideration of the current understanding of the behaviour and dynamics of the attribute.

Furthermore, the decision-making process described in this document to determine HCVF thresholds emphasizes the nature and status of the conservation value. That is, current management practices or regulations are not a consideration for HCVF status, although these may be appropriate considerations to establish the suitable management or monitoring effort of the forest manager.

Two general examples can be used to illustrate the consideration of regional distributions to establish HCVF thresholds.

(1) Moose are common in northern Ontario and even limiting habitat such as moose aquatic feeding areas, is likely not to be considered HCVF. In southern, fragmented landscapes, however, and approaching the southern portion of moose range, it is conceivable that moose aquatic feeding areas can be considered critical habitat and listed as HCVFs.

(2) Bald eagles are listed as endangered in Ontario. Isolated breeding pairs are likely not HCVFs in northern Ontario where populations are more stable than in other areas of the province. However, a cluster of as few as several nests (i.e. several breeding pairs) in a single watershed may constitute a significant concentration that meets HCV thresholds. In this case, the watershed may be designated as a HCVF. In southern Ontario, single nesting pairs may be considered HCVs since these populations have experienced greater historical declines.

During assessment values are designated as HCV, not HCV or *potential* HCV. The potential HCV designation should be used in cases where occurrence is not confirmed, need further information about distribution and abundance, and/or further consultation is required.

Question 19 from the HCVF National Framework pertains to the significant overlap of ecological and/or cultural values that individually did not meet HCV thresholds, but collectively do constitute HCVs. This final analysis step of an HCVF assessment requires that all potential HCVs and those that nearly missed the critical thresholds be tracked and recorded throughout each of the 18 preceding steps of the analysis.

How is scale addressed in the HCVF framework?

Geographic scale is interpreted in two ways throughout this document. Attributes can be listed as globally, nationally or regionally significant. This type of interpretation usually does not change with the geographic scope of the assessment since the rating of risk is often applied by an agency based on objective criteria at various scales (i.e. IUCN red list). That is, the risk rating does not change whether you consider the attribute at a local level or a national level.

A second treatment of scale considers the local forest (i.e. tenure) within the broader regional landscape. In this report, we will illustrate situations where the HCV determination of an attribute within a tenure can be altered by also considering the regional distribution of the attribute. Here, the issue of scale refers to the geographic study area under consideration for a particular conservation attribute.

How does an HCVF assessment relate to comprehensive conservation planning?

Comprehensive conservation planning has a goal to maintain long-term ecological integrity across landscapes through a combination of actions such as best management practices, completing permanent protected areas networks and establishing special management zones to address complimentary conservation values (e.g. caribou calving areas, marten core areas, etc.). It is best to undertake conservation planning across large regions in order to make appropriate decisions about management or strict protection for any particular forest area.

Although we emphasize in this document that consideration of conservation values at a regional scale is more appropriate to make HCV decisions, the nature of the forest tenure system dictates that final HCV recommendations are made at the scale of the forest concession.

Many conservation targets typical of comprehensive conservation planning are addressed in the HCVF assessment. This includes special elements (vulnerable and irreplaceable elements at species and ecosystem scales and wildlife habitat for regionally significant species), habitat condition, ecosystem services, cultural values, and consideration of long-term viability and persistence. The HCVF assessment indirectly considers ecological representation, connectivity, restoration and threats or risk to conservation attributes from sources other than forestry operations.

In this way, the HCVF assessment can be used to inform protected areas planning. Information documented about conservation attributes and thresholds in a HCVF assessment can be used to set protected areas targets. In addition, HCVFs, or HCV zones, can be evaluated for suitability in a permanent protected areas network. Finally, a protected areas design together with HCV zones can be evaluated for conservation effectiveness regarding ecological representation and persistence.

Precautionary approach

Whether an HCVF assessment is undertaken within or outside of an FSC process, we strongly recommend that the investigator is consistent with the precautionary approach expressed in FSC's Principle 9, that "decisions regarding HCVFs shall always be considered in the context of a precautionary approach. " This should apply both at the identification stage and during the determination of suitable management prescriptions to maintain the HCV.

Similar to the discussion regarding HCV thresholds, addressing uncertainty in the application of the precautionary approach will vary by region, situation and practitioner. Some investigators will be more inclusive of values to address uncertainty. That is, HCV thresholds may be relaxed to ensure that potential HCVFs are included. This is more likely to be the case for HCVF assessments conducted for data poor areas or where data is of dubious quality. Where data are scarce for evaluating HCV status, modeling approaches (e.g. predictive habitat modeling) may also need to be considered to estimate expected regional and tenure-scale distributions.

The HCVF National Framework emphasizes that application of the precautionary approach is also an important component of the management of HCVFs.

Threats assessment

Understanding threats to HCVs is critical to understand cumulative impacts and developing effective management prescriptions. Therefore, a threats assessment should be conducted prior to drafting a management plan, and could be incorporated in be into the HCVF assessment. Threats assessments should not be limited to direct and indirect adverse impacts from forest operations, rather they should address the full suite of factors that could adversely impact forest resources. Tourism and other public access for recreational consumption (fishing, hunting, off-road vehicles), other industrial uses, and pollutants may constitute threats that can and should be considered in determining a HCV threshold and setting appropriate management prescriptions given the probabilities of long-term persistence.

Next steps – HCVF management prescriptions and monitoring

Criteria 9.3 and 9.4 of the FSC Canada National Boreal Standard address appropriate management prescriptions and monitoring activities. Management prescriptions for HCVFs are often considered to be enhanced or special management. However, where the existing regulatory requirements have been proven to be effective in maintaining the attributes for which the HCV has been defined, there may not be a need to modify the prescriptions. Furthermore, the potential forestry impact and/or level of protection of the HCVF should also be considered in determining the forest manager's responsibility for management and monitoring.

For example, management prescriptions for HCVs associated with shoreline habitat (i.e. non-forested habitat) may be limited to road and access planning to ensure that opportunities are not created that could potentially increase off-road vehicle traffic and other forms of human disturbance. Similarly, if the entire or critical portion of the distribution of a HCV exists within regulated protected areas, then the agency responsible for the protected areas has a greater obligation for monitoring the portions of the HCV in those areas. Regardless of jurisdiction, monitoring should always be conducted at spatial and temporal scales appropriate to the HCV.

The focus of this support document is on HCVF assessment (Criterion 9.1); WWF and TNC do not address Criteria 9.3 (HCVF management) or 9.4 (HCVF monitoring) here, however it is important to recognize that the four criteria are related and that HCVF assessments are not static documents. The outcomes of monitoring programs need to inform revisions to the thresholds and management strategies in an iterative process. An adaptive approach helps reduce uncertainty encountered during both the assessment and management planning stages.

SPECIES AT RISK

HIGH CONSERVATION VALUE 1, QUESTION 1

Does the forest contain species at risk or potential habitat of species at risk as listed by international, national or territorial/provincial authorities?

BACKGROUND

The term 'species at risk' is widely used in Canada to variously refer to species that are known or considered to be endangered, threatened, of special concern, vulnerable, rare, or extirpated (not extinct, but no longer extant in Canada in the wild). While additional terminology exists depending on the classification system in use, these are the most commonly used terms that classify species at levels of risk. In Canada, geographically isolated or identifiable populations, as well as disjunct or range edge populations can be listed as at risk (separate from other, healthier or less threatened populations of the same species). For example, the national science body for ranking species in Canada (Committee on the Status of Endangered Wildlife in Canada (COSEWIC)) has variously ranked populations of Beluga Whale in Canada as endangered, threatened or special concern depending on a range of factors, including levels and rates of population decline from historical levels and recovery potential in relation to current assessments of threat.

Species at risk warrant special attention in management planning because these are the most vulnerable and/or irreplaceable elements of biodiversity. Species may be at risk due to human caused factors or they may be naturally rare in the landscape. In either circumstance, if their ecological requirements are not addressed, they are at risk of becoming further threatened. While forest management practices may not be directly responsible for a species being listed as 'at risk', it is nonetheless important that forest practitioners are aware of the species if it occurs or has the potential to occur in appropriate habitat in their license area. Subsequent to HCVF assessment and appropriate management planning, steps should be taken to monitor its population levels in order to determine whether further decline is detected.

Depending on the level of risk attributed to a species or population, a single species at relatively high risk or concentration of species at various levels of risk may constitute a HCV and the habitats in which they occur, especially habitat components considered to be critical to the species survival, should be considered as HCVFs.

Species at risk that are not, ultimately, designated as HCVs are still afforded special management strategies under the requirements of Criterion 6.2.

DATA SOURCES

Global/International:

- CITES (Appendix I, II, and III)
- IUCN red data list
- Conservation Data Centre G1 and G2 element occurrences

National:

- Species designated as endangered, threatened or special concern by COSEWIC (see: http://www.speciesatrisk.gc.ca/search/speciesResults_e.cfm)
- Conservation Data Centre N1 and N2 element occurrences

Regional:

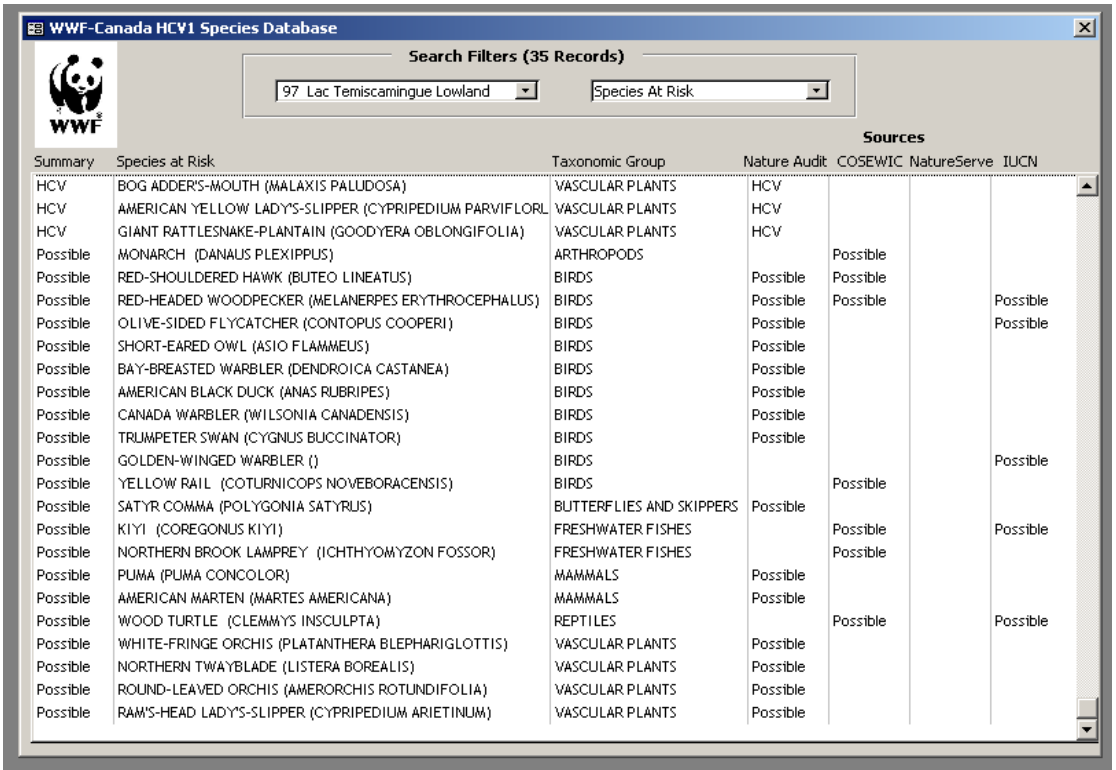
- Provincial/Territorial Government lists (*e.g.* in Ontario consult the Species at Risk in Ontario (SARO) list: http://www.ontarioparks.com/saro-list.pdf)
- Provincial/Territorial Conservation Data Centre S1 and S2 element occurrences (*e.g.* in Ontario go to http://www.mnr.gov.on.ca/MNR/nhic/nhic.cfm; in Alberta go to http://www.cd.gov.ab.ca/preserving/parks/anhic/flashindex.asp; in Quebec go to http://www.cdpnq.gouv.qc.ca/index-en.htm; in Saskatchewan go to http://www.biodiversity.sk.ca/)
- General Status of Wild Species reports on the year 2000 provincial, territorial and national status assessments of Canadian birds, mammals, reptiles, amphibians, freshwater fishes, butterflies, orchids and ferns (http://wildspecies.ca/wildspecies2000). The document is set to be revised and updated in 2005 with proposed additions including marine fishes, crayfish, tiger beetles, dragonflies, freshwater mussels, and all vascular plants (Natural Heritage Information Centre Newsletter, Ontario Ministry of Natural Resources, Vol. 10, No.1, Winter 2005).
- Provincial Breeding Bird Atlases now exist for most provinces. For example, Ontario is currently in the final year of its second 5-year assessment (2001-05), the first survey was conducted from 1981-1985 (see http://www.birdsontario.org/atlas/atlasmain.html).
- Some provinces have also completed mammal and reptile/amphibian atlases

Data sources for digital mapping of species distribution include:

- NatureServe (bird and mammal distributions; see http://www.natureserve.org/getData/birdMaps.jsp http://www.natureserve.org/getData/mammalMaps.jsp)
- Regional CDCs (*e.g.* Ontario Natural Heritage Information Centre; see see websites listed above)
- USGS Trees of North America (see http://climchange.cr.usgs.gov/data/atlas/little/)
- COSEWIC listed species (see http://www.speciesatrisk.gc.ca/search/speciesResults_e.cfm)

HCV1 Q1 – SPECIES AT RISK

Figure 1.1 Sample output from the WWF-Canada HCV1 species database application summarizing the translation of various Species at Risk rankings into HCV recommendations. The details of this translation is provided in the Methodology section



WWF-Canada HCV1 Species Database

Search Filters (35 Records)

97 Lac Temiscamingue Lowland | Species At Risk

Summary	Species at Risk	Taxonomic Group	Nature Audit	COSEWIC (Sources)	NatureServe	IUCN
HCV	BOG ADDER'S-MOUTH (MALAXIS PALUDOSA)	VASCULAR PLANTS	HCV			
HCV	AMERICAN YELLOW LADY'S-SLIPPER (CYPRIPEDIUM PARVIFLORL	VASCULAR PLANTS	HCV			
HCV	GIANT RATTLESNAKE-PLANTAIN (GOODYERA OBLONGIFOLIA)	VASCULAR PLANTS	HCV			
Possible	MONARCH (DANAUS PLEXIPPUS)	ARTHROPODS		Possible		
Possible	RED-SHOULDERED HAWK (BUTEO LINEATUS)	BIRDS	Possible	Possible		
Possible	RED-HEADED WOODPECKER (MELANERPES ERYTHROCEPHALUS)	BIRDS	Possible	Possible		Possible
Possible	OLIVE-SIDED FLYCATCHER (CONTOPUS COOPERI)	BIRDS	Possible			Possible
Possible	SHORT-EARED OWL (ASIO FLAMMEUS)	BIRDS	Possible			
Possible	BAY-BREASTED WARBLER (DENDROICA CASTANEA)	BIRDS	Possible			
Possible	AMERICAN BLACK DUCK (ANAS RUBRIPES)	BIRDS	Possible			
Possible	CANADA WARBLER (WILSONIA CANADENSIS)	BIRDS	Possible			
Possible	TRUMPETER SWAN (CYGNUS BUCCINATOR)	BIRDS	Possible			
Possible	GOLDEN-WINGED WARBLER ()	BIRDS				Possible
Possible	YELLOW RAIL (COTURNICOPS NOVEBORACENSIS)	BIRDS		Possible		
Possible	SATYR COMMA (POLYGONIA SATYRUS)	BUTTERFLIES AND SKIPPERS	Possible			
Possible	KIYI (COREGONUS KIYI)	FRESHWATER FISHES		Possible		Possible
Possible	NORTHERN BROOK LAMPREY (ICHTHYOMYZON FOSSOR)	FRESHWATER FISHES		Possible		
Possible	PUMA (PUMA CONCOLOR)	MAMMALS	Possible			
Possible	AMERICAN MARTEN (MARTES AMERICANA)	MAMMALS	Possible			
Possible	WOOD TURTLE (CLEMMYS INSCULPTA)	REPTILES		Possible		Possible
Possible	WHITE-FRINGE ORCHIS (PLATANTHERA BLEPHARIGLOTTIS)	VASCULAR PLANTS	Possible			
Possible	NORTHERN TWAYBLADE (LISTERA BOREALIS)	VASCULAR PLANTS	Possible			
Possible	ROUND-LEAVED ORCHIS (AMERORCHIS ROTUNDIFOLIA)	VASCULAR PLANTS	Possible			
Possible	RAM'S-HEAD LADY'S-SLIPPER (CYPRIPEDIUM ARIETINUM)	VASCULAR PLANTS	Possible			

INTERPRETING GLOBAL, NATIONAL AND REGIONAL SIGNIFICANCE

<u>It is important to consider the global, national and regional context of a species or population at risk.</u> For most listed species at risk, maintaining all remaining meta-populations (including those at the regional level where populations may be stable and healthy) is important for preventing further decline and ultimately, to provide opportunities for recovery.

Inclusion of international and national rankings is especially important since a listed species may be locally common, perhaps even abundant even as it is in decline in other significant parts of it's range. In these cases it is possible that the healthiest populations are restricted to a region that includes the license area, which could confer a special responsibility on the forest practitioners to maintain the health of the regional population.

Alternatively, some species may be regionally at high risk or even extirpated while populations elsewhere in its range may be stable. Efforts to help recover the species at the regional level would assist in preventing the species from potentially undergoing further decline. Depending on the specific circumstances (*e.g.* a species that is a top predator or important ungulate) recovery of local populations may help to improve the ecological integrity of the regional forest system in a manner that is beneficial to tree regeneration (reduced browse from small mammals with re-introduction of predators) or community recreational benefits (restored hunting/fishing opportunities).

INTERPRETING THE PRECAUTIONARY PRINCIPLE

Species listed as 'at risk', regardless of specific level of threat, have a greater probability of being negatively influenced, either directly or indirectly, by anthropogenic factors that alter the natural composition or evolutionary processes of their native landscapes.. Collectively, species at risk are therefore often seen as among the most sensitive indicators of ecologically unsustainable activities in the forest.

Species at risk merit careful consideration in selecting HCVs, especially since many species that are rare may not have been well surveyed in much of the boreal. Many plants and insects, in particular, may not be well documented. In these cases, it would be prudent to identify habitats within the forest license area that could potentially support populations of these species, either for recovery purposes or to increase survey efforts for these species if they are less well known. This is especially true of any species that continues to show evidence of population decline or range retraction. Regardless of it's specific at risk status, the

HCV1 Q1 – Species at Risk

HCV status of these species should be carefully considered.

In those cases where sites could support active recovery efforts, they should be identified as HCVFs and management practices should be designed that help restore or conserve habitat conditions necessary for population maintenance or re-introduction. An example of such a measure is the work being undertaken in Manitoba (Pine Falls) to ensure adequate conifer regeneration in order to ensure a future supply of habitat blocks for a small herd of woodland caribou.

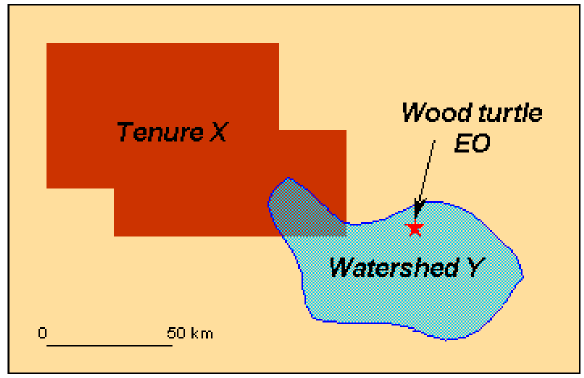
Concentrations of species at risk in the boreal (*e.g.* orchids, turtles, dragonflies, waterfowl) are often associated with various wetland habitats (bogs, fens) nested within the forested landscape. Although unlikely to be directly influenced by forestry activities, these sites may be indirectly impacted through location of nearby logging roads, winter roads, and increased human access. It is therefore important to also identify these non-forested habitats as HCVFs to flag their regional importance and to ensure that indirect effects of forestry operations to not compromise their ecological integrity.

Additional Guidance

In order to assist with the identification of species at risk that could potentially occur within a forest license area, WWF has assembled a regional database using the framework of the Terrestrial Ecoregions of Canada (Figure 1.1 illustrates sample output for Ecoregion 97, the Lac Temiscamingue Lowland). Species (most vertebrates with some examples from other taxonomic groups) in each region have been categorized as either qualifying for HCV status (if also present in the licence area) or as possible HCVs that will require further assessment relative to their status within the licence area. Some of these 'possible HCVs' could then also be elevated to the status of HCVs (either individually or where concentrations of species exist). Generally speaking, species that have been assessed as being at a higher level of risk (*e.g.* endangered, threatened status) among different assessment protocols are most likely to qualify as HCVs. Classification within all at risk protocols is reflective of changes to population and abundance levels as well as overall contraction of range area. For more details on how HCV thresholds were determined, see the methodology section of this document.

Because a forest license area will usually overlap only a portion of a terrestrial ecoregion and may, in fact, overlap parts of several regions, the species lists generated in the look-up table are only meant to provide guidance with respect to the generation of a comprehensive species at risk list. We suggest that HCVF assessments use the regional lists generated by this tool as a starting point for consideration of HCVs under this indicator. For each species listed (both proposed HCVs and possible HCVs) for the region, a rationale specific to its status in the licence area should be provided relative to its final determination as an HCV or not.

Figure 1.2 Location of the hypothetical wood turtle element occurrence relative to the forest tenure in question.



Please note that this table is still under development. Presently, it includes COSEWIC listings, IUCN Red List data, and summarizes species information from <u>The Nature Audit</u>, a report that WWF released in 2003. We anticipate adding new fields into the table that reflect the Natureserve G, N, and S ranks. Until information from other ranking systems are included in the table, the forest practitioner should ensure that these data sets are also considered in their assessment.

Examples

<u>Species with well defined natural history requirements – Wood Turtle (*Clemmys insculpta*)</u>

Many species of reptiles, both globally and in Canada, have conservative life history strategies and populations that are in decline. Many species have relatively low reproductive rates; adults are long-lived and slow to reach sexual maturity. Loss of adults and juveniles can create a rapid decline in local population levels. Specific threats include changes to habitats that increase their vulnerability to mortality on roadways, loss of natural foraging habitat adjacent to waterways, illegal collection of adults for the pet trade and increased predation levels on eggs and young juveniles from raccoons, skunks, *etc.* where populations of these species have increased in the landscape (often in response to habitat changes as a result of human encroachment).

Wood turtle, specifically, is listed by COSEWIC as Special Concern, and by IUCN as Vulnerable, and is therefore shown as a possible HCV in the WWF-Canada HCV1 database (Figure 1.1).

Generalized range maps show that this species' range potentially overlaps the (hypothetical) tenure in question. Known and historical population information for wood turtle indicates that the species' range overlaps the tenure, but that the distribution in Ontario is highly fragmented. This means that if any one population is extirpated, there is a low probability of re-establishment through the 'rescue effect' from neighbouring populations.

Figure 1.3 Delineation of the critical habitat zone for wood turtle is defined using a 300m buffer around all streams (Avisais *et al.* 2002)

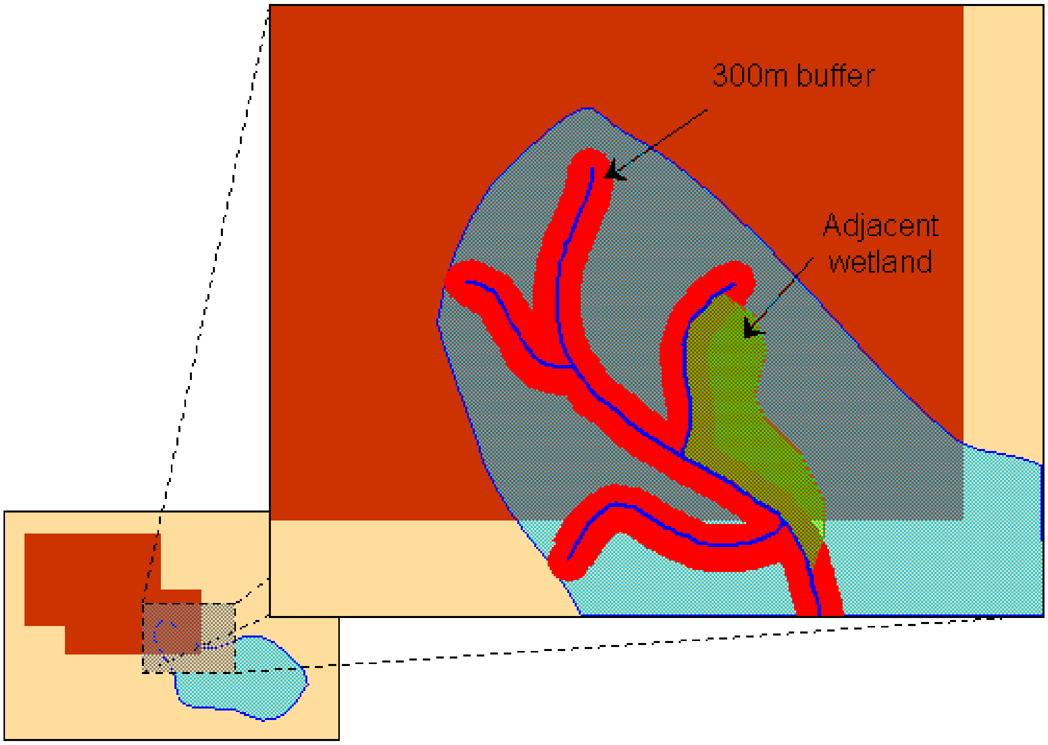
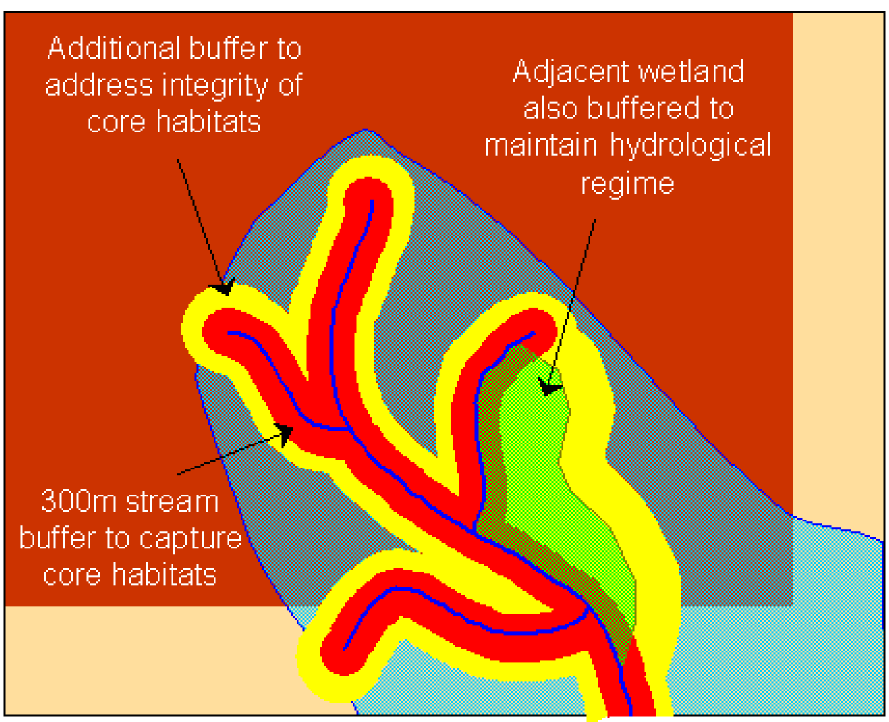


Figure 1.4 The proposed HCVF zone design guidelines incorporates buffers around all critical habitat and wetlands to maintain the integrity of these areas.



HCV1 Q1 – SPECIES AT RISK

Specific occurrences of wood turtle in Ontario are tracked by the Natural Heritage Information Centre (http://nhic.mnr.gov.on.ca/nhic_.cfm), but the distribution of these occurrences may not be comprehensive. In general, element occurrence data tend to be biased towards areas that are easily accessible and commonly travelled, and suffer from greatly uneven survey effort, particularly in the boreal. Absence of element occurrence data does not necessarily mean absence of the species. Similarly, special management of an element occurrence "point" does not necessarily ensure that the critical habitat components sustaining that occurrence are maintained. Some attempt to note past survey effort may help determine the need to document an extended 'potential' distribution .

In this fictitious example, there is only a single occurrence, located just outside the tenure, but within a watershed that it intersects (Figure 1.2). The first step is to map out the watershed encompassing known occurrence.

Life history attributes, population/range area trends, potential threats and critical habitat requirements need to be compiled for each candidate HCV species to determine what spatial areas on the tenure may need to be delineated as HCVF zones. Consultation with local/regional biologists and a review of the literature should assist with assemblage of this information and its application to the forest tenure under investigation.

In the case of wood turtle, Arvisais *et al.* (2002), working with populations of wood turtles in the Mauricie region of Québec, identified a 300 m buffer around streams as sufficient to capture all critical habitat over a two-year period (Figure 1.3).

Major differences in habitat types within this critical area need to be distinguished so that differences in management prescriptions that could impact the ecological integrity of these sites can be addressed. Figure 1.4 illustrates proposed HCVF zone design guidelines and management options. Specific proposals include:

- All streams, wetlands and buffers are considered possible HCVFs
- Additional buffering to the 300 m core may be needed to reduce or minimize threats to wood turtle habitat.
- No roads in 300 m core buffers that border all waterways in the watershed where wood turtles have been recorded.
- No roads or other activity in wetlands or adjacent areas that could alter hydrological conditions
- Careful consideration of roads in the areas demarked by yellow buffers as they may create impacts on the integrity of the core habitat areas and potentially allow for increased access to wood turtles by collectors for the illegal pet trade. Any harvest in these areas should be of a nature that maintains the quality of the 300 m core area.
- Note that buffers need to be wider next to wetlands as these habitats are especially vulnerable to changes in hydrological conditions.
- Any seasonal activity should be timed to avoid turtle activity.

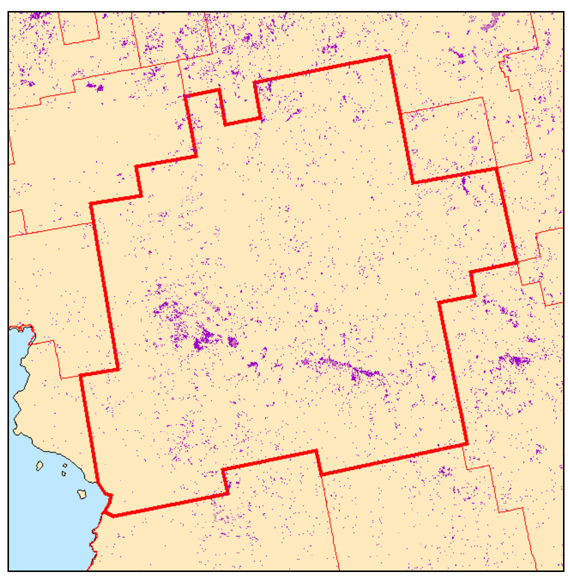
<u>Species with less well-defined natural history requirements and/or knowledge of its population distribution – Bog Adder's Mouth (*Malaxis paludosa)*</u>

This is a typical species for which the precautionary principle needs to be considered. Bog adder's mouth is a small, inconspicuous bog orchid. It is almost certain that all occurrences have not been mapped and, in fact, the majority of populations may be unknown. This is the case with many cryptic species. While not listed by IUCN or COSEWIC, bog adder's mouth is categorized by NatureServe as S1 in Ontario, Manitoba, Saskatchewan and Alberta,, and was identified as a likely HCV by the Nature Audit species evaluation (Figure 1.1).

Range maps are often not available for such inconspicuous species or species difficult to identify. Known occurrences within an ecoregion can provide some evidence that the species may be locally present in suitable habitat. In lieu of recent surveys, the precautionary principle should be applied to help guide management planning where activities may impact suitable habitats (possible HCVFs).

A good first step in considering possible HCV species occurrences within a tenure is to look for records in the ecoregion within which a tenure is located and then look for potentially suitable habitats that could support populations of the species being investigated. Figure 1.5 illustrates the distribution of potentially suitable habitat for bog adder's mouth based on remotely sensed land cover data selecting open and treed bogs. These areas could be considered as possible HCVFs until further survey work is undertaken.

Figure 1.5 Distribution of potentially suitable habitat for bog adder's mouth, *<u>Malaxis paludosa,</u>* in a hypothetical tenure (based on Land Cover 2000 Open and Treed Bogs).



While there is a higher probability that the orchid may be found in areas of higher concentrations of suitable habitats (*e.g.* the linear concentration of wetlands in the lower-central part of the fictitious tenure pictured in Figure 1.5), with naturally occurring rare species there is no guarantee that this will be the case. It is entirely possible that if they do occur in the tenure, it could be in any of the wetlands, even some of the more isolated and smaller habitat sites and that they would not, in fact, be found in the areas of concentrated suitable habitat. In a situation where a species distribution is thought to be poorly known, all occurrences of suitable habitat should remain as possible HCVFs. While there may be a temptation to parcel out a subset of sites as possible HCVFs (*e.g.* concentrated areas of suitable habitat) and eliminate the remainder for consideration prior to site-by-site inspection, this would be a premature move and would not be seen as consistent with the precautionary principle.

Habitat preferences for all likely or possible HCV species should be identified prior to the process of delimiting HCVFs. This is because some habitats or combinations of habitats may emerge as critical for a group of species, hence making the HCVF identification process more efficient if it is conducted with all critical habitat types identified for HCV species occurring or potentially occurring in the tenure.

SUMMARY OF RECOMMENDATIONS

- Species and populations that are most at risk (endangered, threatened) almost certainly need to be recognized as HCVs. Habitat areas critical to their persistence (breeding, staging, feeding) should further be recognized as HCVFs.
- Species occurring in non-forested habitats (*e.g.* wetlands) nested within the forest licence area also qualify as HCVs These non-forested habitats should also qualify as HCVFs.
- Most spatial data on species at risk occur as “point data” marking the occurrence of the species. Therefore, a buffer zone will needed to adequately protect the speices. This buffer zone should be sized and distributed according to the habitat needs of the species in question.
- Species considered to be at somewhat lower levels of risk (*e.g.* Special Concern, Vulnerable, Rare, populations in decline, but not yet formally listed) may also qualify as HCVs, particularly if they:
  - o Are presently known to be experiencing continuing population decline or range retraction (relative to historical levels)
  - o Are known to be vulnerable to changes in their habitat conditions caused directly by forestry operations and/or indirectly by its related infrastructure (*e.g.* roads, increased human access)
  - o Occur in concentration in a particular habitat or region

LITERATURE CITED

Arvisais, M., J. Bourgeois, E. Levesque, C. Daigle, D. Masse and J. Jutras. 2002. Home range and movements of a wood turtle (*Clemmys insculpta*) population at the northern limit of its range. Canadian Journal of Zoology 80(3):402-408

World Wildlife Fund Canada. 2003. The Nature Audit: Setting Canada’s conservation agenda in the 21st century. Report No. 1–2003. WWF-Canada, Toronto, Canada.

METHODOLOGY

Species at Risk Look-up Table

IUCN Data

- COSEWIC ranks were mapped directly to HCV recommendations as follows:
  - o HCV – Any taxa listed as Critically Endangered or Endangered
  - o Possible HCV – Any taxa listed as Near Threatened, Vulnerable or any category of Lower Risk

COSEWIC Data

- COSEWIC ranks were mapped directly to HCV recommendations as follows:
  - o HCV – Any taxa listed as Threatened, Endangered or Extirpated
  - o Possible HCV – Any taxa listed as Special Concern

Nature Audit Data

- Nature Audit data was originally tabulated for each Conservation Planning Region (CPR) in which a given species occurred
- HCV designation was determined on a CPR basis and then sampled down to the Ecoregion level through examination of range extents for each species
- HCV designation was determined using four qualitatively coded attributes from the Nature Audit database:
  - o Overall Abundance of the Species at Present (2000)
  - o Abundance Trend for the Species from pre-European settlement (ca. 1600) to the Present (2000)
  - o Range Extent at Present (2000)
  - o Range Trend for the Species from pre-European settlement (ca. 1600) to the Present (2000)
- Separate HCV designations were determined for abundance and range data, using the matrices illustrated in Table 1.1 and Table 1.2, respectively
- A Final HCV designation for Nature Audit data was derived through combination of the abundance and range designations using Table 1.3

Summary Rank

- A summary HCV rank was assigned based on the highest rank assigned by any of the available data sourc

HCV1 Q1 – Species at Risk

Table 1.1 Matrix translating Nature Audit abundance data to HCV ranks.

		Abundance Trend from Pre-European Settlement to 2000				
		Decreased > 50%	Decreased > 20%	No Change (± 20%)	Increased > 20%	Increased > 50%
Abundance in 2000	Abundant					
	Common					
	Uncommon					
	Rare					

Table 1.2 Matrix translating Nature Audit range data to HCV ranks.

		Range Trend from Pre-European Settlement to 2000				
		Contracted > 50%	Contracted > 20%	No Change (± 20%)	Expanded > 20%	Expanded > 50%
Range Extent in 2000	Widespread					
	Regional					
	Restricted					
	Very Restricted					
	Extirpated	Likely HCV – Habitat Restoration				

Table 1.3 Matrix translating Nature Audit range and abundance ranks to a summary HCV rank.

		Abundance Designation		
		Likely HCV	Possible HCV	Not HCV
Range Designation	Likely HCV			
	Possible HCV			
	Not HCV			

= Likely HCV
= Possible HCV
= Not HCV

CONCENTRATIONS OF ENDEMIC SPECIES

HIGH CONSERVATION VALUE 1, QUESTION 2

Does the forest contain a globally, nationally or regionally significant concentration of endemic species?

BACKGROUND

The Committee On the Status of Endangered Wildlife in Canada (COSEWIC) defines endemic species as a species native and confined to a certain region; having comparatively restricted distribution. Endemism tends to be most prevalent in tropical ecosystems with great species diversity and specialized habitats and on islands where breeding populations are isolated for many generations. These specialized habitats allow species to specialise, adapt, and eventually to evolve into different species. .

The restricted global range area characteristic of many endemic species makes them especially vulnerable to changes in the habitat conditions or introduced competitors and/or predators. Endemic species are often unable to readily adapt to these habitat modifications or quickly expand their range area so disturbance or loss of suitable habitat (including changes in forest structure, establishment of invasive species) typically results in permanent loss of local or regional meta-populations.

Only one to five percent of Canadian species are endemic to the country (Canadian Biodiversity/McGill, however a greater (but still relatively small) number of species are endemic breeders (i.e., breed only in Canada or within a narrow range) or have distinct and restricted ranges of subspecies. For example, several endemic species of plants and animals and an endemic subspecies of black bear occur on Haida Gwaii/QCI; an unusual white form of the black bear—the Spirit bear—lives on Princess Royal Island; and a

While loss of endemic species is most often a concern for tropical or temperate systems, there are some applications to Canada's forests, espeically at the regional scale.

DATA SOURCES

As currently noted in Appendix 5 of the FSC Canada, National Boreal Standard, local authorities on species groups and known or expected range distributions will need to be consulted to determine if there are concentrations of endemic species in an ecoregion where a forest license is located.

Some data sources that may provide general guidance on levels of endemism for coarse scale ecoregion assessments include:

- WWF Ecoregion Conservation Assessment (see www.panda.org)
- Conservation International Hotspot Areas (see www.conservation.org)
- Atlas of Canada Endemic Plant Diversity (http://atlas.gc.ca/site/english/maps/environment/ecology/components/endemicplantdiversity)

Data sources for digital mapping of species distribution include:

- NatureServe (bird and mammal distributions and bird breeding ranges; see http://www.natureserve.org/getData/birdMaps.jsp http://www.natureserve.org/getData/mammalMaps.jsp)
- Regional CDCs (*e.g.* Ontario Natural Heritage Information Centre; see http://www.mnr.gov.on.ca/MNR/nhic/nhic.cfm)
- USGS Trees of North America (see http://climchange.cr.usgs.gov/data/atlas/little/)

DEFINING POPULATIONS IN THE BOREAL AS 'ENDEMIC'

For the most part it will not be common anywhere in the boreal forest to locate a globally or nationally significant concentration of endemic species. This, in part, can be attributed to the relatively broad ranges of most vascular plant and vertebrate species common to the boreal and the fact that much of the boreal has only recently migrated into its current geographical distribution since the last glacial period. This has resulted in insufficient evolutionary time for regional differentiation (genetic drift) of populations into locally restricted or 'endemic' species.

At the regional level however, concentrations of sub-species and isolated or disjunct populations of more broadly ranging species may occur. This is particularly true for areas in close proximity to unusual microclimatic or geomorphologic conditions or glacial refugia.

For example, of the approximately 3,200 species of vascular plants that have been identified as native to Canada, about are 150 endemic species (Botanic Gardens Conservation International). The concentration of these species is in areas that possess unique characteristics such as the central Yukon, the Athabasca sand dunes, and the isolated Queen Charlotte Islands. These plants have genetically adapted to these particular environmental conditions. Figure 2.1 shows the distribution and concentration of endemic plant species in Canada.

The Aurora trout (Salvelinus fontinalis timagamiensis in central Ontario provides another example. It is endemic to only two small lakes, and is thought to be the product of the isolation of a population of brook trout after the last glaciation. The Aurora trout is listed as endangered by COSEWIC as a result of lake acidification, and extensive restoration work has been undertaken to reverse its decline (Snucins et al. 1995).

Similar to Question 1, it is recommended that the Terrestrial Ecoregions of Canada be used as a guiding regional framework within which to determine whether the ranges of species, sub-species, breeding areas or disjunct populations are sufficiently restricted to qualify as regionally endemic.

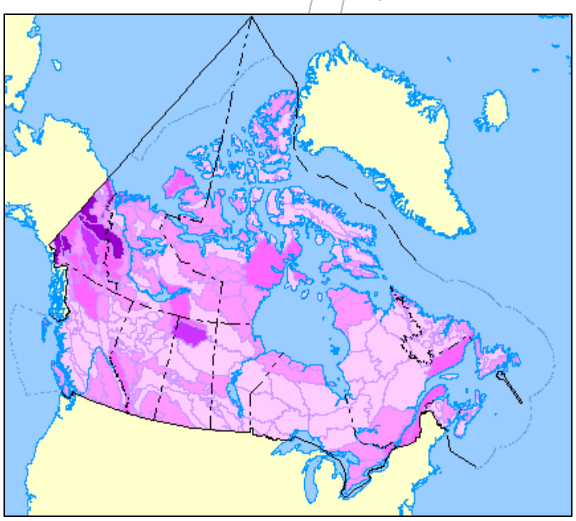
INTERPRETING THE PRECAUTIONARY PRINCIPLE

As noted above, a geographically restricted critical life stage, such as breeding, is often considered an important facet of endemism. For example, while many migratory songbirds have large global ranges, many breed only or primarily within the boreal forest. If the majority of a bird's breeding range is restricted to a single ecoregion, then significant concentrations of suitable breeding habitat should be taken under consideration for HCVF status.

For example, *the* Cape May warbler (*Dendroica tigrina*) breeds mostly within the allocated southern boreal forest region and prefers dense black spruce stands. Conversion of these spruce stands to other forest stand types within a license area could result in the loss or reduction of local populations.

Spatial information on breeding ranges can be acquired online from NatureServe at no cost (http://www.natureserve.org/getData/birdMaps.jsp; Ridgley *et al.* 2003).

Figure 2.1 Distribution and concentration of endemic plant species in Canada (source: The Atlas of Canada)



0 1-3 4-7 8-11 12-15

Number endemic plan species

SUMMARY OF RECOMMENDATIONS

Most endemism in Canada is regionally, not nationally or globally significant. Thus, recommendations focus on the regional scale of analysis:

- Select the Terrestrial Ecoregions of Canada as a guiding regional framework
- Consider the following species taxonomic and life history attributes when identifying geographically (regionally) restricted distributions.
    - Sub-species
    - Disjunct and/or reproductively isolated populations
    - Breeding areas (especially for migratory species).

LITERATURE CITED

Snucins, E., J. Gunn and W. Keller. 1995. Restoration of the Aurora trout to its acid-damaged native habitat. Conservation Biology 9(5) : 1307-1311

Ridgely, R.S., T.F. Allnutt, T. Brooks, D.K. McNicol, D.W. Mehlman, B.E. Young, and J.R. Zook. 2003. Digital Distribution Maps of the Birds of the Western Hemisphere, version 1.0. NatureServe, Arlington, Virginia, USA.

Canadian Biodiversity McGill: http://www.canadianbiodiversity.mcgill.ca/english/patterns/canadian.htm

Botanic Gardens Conservation International: http://www.bgci.org.uk/canada/plant_conservation.html

SEASONAL CONCENTRATIONS OF SPECIES

HIGH CONSERVATION VALUE 1, QUESTION 3

Does the forest include critical habitat containing globally, nationally or regionally significant seasonal concentration of species (one or several species, e.g., concentrations of wildlife in breeding sites, wintering sites, migration sites, migration routes or corridors -latitudinal as well as altitudinal)?

BACKGROUND

Species congregate seasonally for a variety of reasons, including to breed, prepare for migration, give birth, and feed on a limited or episodically available resource. Often seasonal concentrations of species coincide with life stages that are critical for the continued survival and/or reproduction of individuals and populations. Breeding and birthing are two obvious examples, however concentrations driven by a limiting resource may also be critical for survival, especially if a resource is uncommon across the landscape and alternative supplies are not available.

The Proximity of one limiting resource to another (*e.g.* breeding, foraging, and roosting sites) may also be critical in sustaining a wildlife population. For example, stands of mature trees with suitable nesting sites for bald eagles or heron colonies need to be located within range of suitable foraging habitat (*i.e.* water bodies and wetlands) in order for the trees to be potentially utilized for nesting. If only one of these resources were present, it is unlikely that there would be regional breeding populations of these species.

Determining what constitutes a threshold for seasonal concentration will generally need to be considered on a species by species basis. Seasonal concentrations are tied to the relative distribution and abundance of resources across a regional landscape. The more concentrated and local a limiting resource may be, the greater the likelihood that there will be a corresponding seasonal concentration of species dependent on the resource. Further, given that the distribution and abundance of some resources will vary from region to region, thresholds for what may constitute a concentration for an individual species may also vary across regions.

DATA SOURCES

As thresholds for defining a seasonal concentration will vary by species, wildlife biologists, traditional knowledge and local experts should be consulted to determine areas and landscape features that might qualify as supporting seasonal concentrations of wildlife.

Nationally, important sites for birds can be obtained from Bird Studies Canada and Conservation International. As well, national and local government agencies with responsibility for wildlife conservation should be consulted as they may monitor such features as deer wintering areas, moose feeding areas, fish spawning areas, colonial nesting birds and/or caribou calving areas among others (e.g. Ontario Ministry of Natural Resources' NRVIS database, Alberta Environmentally Significant Areas studies – http://www.cd.gov.ab.ca/preserving/parks/anhic/esa.asp).

At the Global level, some conservation organizations have listed the locations of wildlife hot spots, some of which might represent significant seasonal concentrations. These organizations include Bird Life International (Important Bird Areas), Audubon Society and Conservation International.

DEFINING SIGNIFICANT SEASONAL CONCENTRATIONS

Global concentrations

This term is best applied to concentrations of individuals that represent a significant proportion of individuals or populations constituting the full range of a species distribution. Often, but not always, this can be interpreted in Canada by looking at the overall seasonal distribution of a species within its continental (North American) distribution. Where large numbers of a single species or multiple taxa congregate in a restricted area along a migration route (*e.g.* staging areas along flyways), a wintering area, or if breeding areas are concentrated or of a colonial nature, these geographic sites could constitute a globally important concentration. Many species of waterfowl and shorebirds exhibit this seasonal pattern, especially when staging during migration and on their wintering grounds. For these species, coastal wetlands in key areas are critical feeding areas that enable birds to store enough fat to fuel the next phase of their migration. Any reduction in the quality or quantity of the resource could have major implications for the global status of the species.

National or Regional Concentrations

Sites that may not qualify as significant global concentrations, but can still be characterized as locations where wildlife habitually congregates may be important for sustaining ecoregional or local populations. As noted earlier, the number of individuals constituting a concentration will depend on the behavioural characteristics of individual species. For example, a gathering of 12 caribou (out of a herd of 100 animals) in habitat suitable for calving may constitute a significant regional concentration, as it would likely represent a high proportion of calving females whereas a flock of 12 Canada geese staging along a flyway would not likely register as a significant concentration given the potentially larger numbers of individuals passing through the region during migration.

Regardless of scale (global to regional), practitioners should consider the characteristics of the appropriate life history stage when determining what constitutes a significant seasonal concentration of wildlife.. The number of individuals that might constitute a concentration during a migration phase could be different than numbers of individuals forming a concentration during the breeding season. A highly productive wetland complex might support a concentration of breeding pairs of waterfowl numbering in the hundreds, but during migration the same wetlands may support tens of thousands of staging birds. Both of these situations could potentially qualify the wetlands as areas of seasonal concentration for waterfowl, one reflecting the breeding season, the other the migration period.

INTERPRETING THE PRECAUTIONARY PRINCIPLE

To support seasonal concentrations of species, the access to and ecological integrity of the habitat, process or resource that draws the species must be maintained. For example, natural stream flow regimes must be maintained to sustain fish spawning aggregations. This may require that in addition to the spawning area, the forest areas surrounding the stream may also need to receive a HCVF designation if their conservation is central to maintaining the ecological quality of the core site.

ADDITIONAL GUIDANCE

Consideration of scale is relevant to the assessment of seasonal concentration. For example, within a tenure a species may be thought of as a locally abundant breeder, whereas on a continental scale, the local area in which a tenure is located may be seen as a significant concentration of breeding pairs. Hence the local, regional and continental/global scales should each be considered on a case-by-case basis to determine what may constitute a seasonal concentration of a species. Guidance on this issue will be best provided by wildlife experts.

SUMMARY OF RECOMMENDATIONS

Seasonal concentrations of species are linked to the regional availability of limited resources critical to one stage of a species life history. Seasonal concentrations are variously associated with breeding, staging, molting, rutting, calving, feeding or wintering areas; by assessing the distribution of the limiting resources or habitat conditions suitable for these life history stages, a practitioner can begin to define possible geographic locations for HCVFs for seasonal species concentrations within the tenure.

REGIONALLY SIGNIFICANT SPECIES

HIGH CONSERVATION VALUE 1, QUESTION 4

Does the forest contain critical habitat for regionally significant species (e.g., species representative of habitat type naturally occurring in the management unit, focal species, species declining regionally)?

BACKGROUND

Most definitions of 'critical habitat' include the habitat that is necessary for the survival or recovery of a species and on which are found those physical or biological features essential to its conservation. These include habitats that are critical for one or more life stages

Determining what qualifies as a 'regionally significant species' can be a challenging question. Unlike some of the previous HCVF indicators where strict definitions apply to species classifications (*e.g.* COSEWIC definitions), regionally, there is often more variation in the interpretation of what constitutes significance. In addition, it can be difficult to determine if habitat types that naturally occur within a management unit constitute critical habitat for regionally significant species in part because the naturally occurring habitat types may have been altered in structure and/or distribution.

In most cases, consultation with qualified ecologists (specialists) will be required to complete this section.

DATA SOURCES

Possible sources of data to be used in selecting regionally significant species include:

- Conservation data centres (especially S1-S3 species and communities)
- Species representative of habitat types naturally occurring in the management unit
- WWF-Canada Nature Audit information on estimated levels of species disruption from historical baseline (circa 1600).
- Species for which federal, provincial or regional harvesting or management guidelines exist

INTERPRETING REGIONAL SIGNIFICANCE

Identifying a species as 'regionally significant' can result from a number of different considerations, including:

- Species that are considered to be an important (co-dominant or dominant) component of the natural communities in the region
- Top carnivore or dominant ungulate species that if removed from the system or elevated to high population levels would create significant disruption to the system (*e.g.*, explosions in small herbivore populations if carnivores removed; over browsing of tree regeneration by elevated populations of deer or moose)
- Species that are resource limited (*e.g.* cavity nesters)
- Species that are process limited (*e.g.* dependent on natural disturbances such as fire)
- Species that are dispersal limited (*e.g.* plants, amphibians, reptiles, some invertebrates)
- Species that are area limited (*e.g.* wide-ranging species, those requiring large blocks of continuous forest cover)

INTERPRETING THE PRECAUTIONARY PRINCIPLE

A precautionary approach to addressing this question will include consideration of species that may have significantly declined in population or distribution. It will also include an evaluation of the current and past status of the critical habitats for these species. In many areas, reliable historical data on species populations and ranges may be difficult to locate, interpret or simply doesn't exist for a given license area. Where human disturbance has been minimal across the landscape the current state may be appropriate for establishing a baseline. However, where habitat modification has occurred more extensively and/or intensively, it may be much more difficult to determine if critical habitats exist.

ADDITIONAL GUIDANCE

This indicator addresses the habitat needs of regionally significant species representing the range of coarse-scale habitats in the region that are important for sustaining meta-population viability. The challenge is to select species that are truly regionally significant and that can be considered collectively as effective indicators of the naturally occurring landscape, which in some areas has been significantly altered by human disturbances. Their continued viability in a working landscape would therefore be a strong indicator of ecologically sustainable practices across the licence area. As well, sustaining these species would indicate a higher probability that the ecological requirements of a broad spectrum of the region's biodiversity are also being met.

Two key components that help classify critical habitats in the boreal are vegetation structure and composition. Table 4.1 proposes a coarse scale template for selecting regionally significant species that when considered together, would represent a majority of habitat types and seral stages within the license area.

HCV1 Q4 – Regionally Significant Species

Significantly upward or downward population trends/increased or reduced range areas from predicted baseline status

Species which have shown major shifts in population size or range area within the region due directly or indirectly to past and/or continuing human activities should receive priority consideration as regionally significant species under this indicator. Species that may have declined regionally to the extent that they are in danger of becoming locally at risk may be at or close to their current range edge. In these cases, identifying critical habitat as a HCV could help restore the species to its baseline status.

While assessments need to consider species that have declined significantly there is also a need to address those that have undergone a range expansion or increased population levels significantly (*e.g.* ungulates such as moose or white-tailed deer; early successional species such as aspen). These species often have more information available on their abundance and range and can act as a surrogate to estimate potential declines among other species (as a result of inter-specific competition) within the boreal community.

Dispersal limited species

While many species in the boreal system have evolved to a shifting mosaic of habitat types following fire and insect outbreaks, other species are more conservative in their dispersal abilities. In particular, many plants and invertebrates are unable to easily disperse rapidly or across large distances. This has implications for defining what constitutes critical habitat. For example, many species of wetland flora (*e.g.* orchids) are sensitive to water level fluctuations and this critical habitat parameter is linked to the natural hydrological regime of the watershed. Identifying these critical habitat elements may be critical to preventing the decline of these species locally.

Habitat connectivity is also important for some species, allowing them to effectively disperse from one habitat block to another within the shifting mosaic of the boreal system. Riparian forest corridors may be important in this regard.

Process limited Species

The critical habitat elements for some species are linked to the frequency and intensity of natural disturbance processes such as fire and insect outbreaks. For example, the populations of insect eating songbirds fluctuate in response to the timing and size of insect outbreaks. Widespread suppression of disturbance processes or truncation of mature forest stages (through harvest rotations that are shorter than natural disturbance frequencies) could impact process dependent species by eliminating periodic opportunities to build up local populations. Therefore it is important to consider and identify the full suite of elements that constitute critical habitats during the HCVF assessment.

Resource limited

The key resources that are required for critical stages of a species' life history need to be continuously supplied within a regional landscape in order for meta-populations to be maintained. Examples of limited forest resources important to wildlife species include nesting or roosting cavities for birds, small mammals

Table 4.1 Preliminary example of regionally significant species for terrestrial ecoregion 94. This species list is not complete and ideally should include a greater diversity of taxa, especially among invertebrates and vascular plants, and be informed by experts with local knowledge.

	Forest Habitat			**Interspersed Non-forested Habitat**		
	Conifer dominated	*Mixed-wood*	*Deciduous dominated*	*Grasslands*	*Wetlands*	*Aquatic*
Mature/ Old-growth	Marten[1] Caribou[1,2] Barred owl[2]	Caribou[1,2] Hairy woodpecker[2]	Hairy woodpecker[2] Blue-spotted salamander[3] Black Ash		**(Bog)** Caribou[1,2]	**(River)** Lake Sturgeon[5]
Mid-Successional	Marten[1]	Great-crested flycatcher[2] Hairy woodpecker[2]	Hairy woodpecker[2] Blue-spotted salamander[3] Black ash	Elk[1]	**(Marsh)** Goldeneye[2] Bufflehead[2] Hooded Merganser[2]	**(Lake)** Lake Sturgeon[5]
Early Successional	Black-backed woodpecker[4]	Black-backed woodpecker[4]	Black-backed woodpecker[4]		**(Fen)** Orchids, Sedges[3]	

[1]Area limited [2]Resource limited [3]Dispersal limited [4]Process limited [5]Species in decline

and some invertebrates, large trees for platform nesters (*e.g.* bald eagles, osprey) and abundant late-summer seasonal foods (*e.g.* berry crops) needed to create fat reserves for migration or over-wintering. Diminishing the supply of a species' key resources may lead to regional abandonment of ranges or significant regional population decline. Again, it is important to consider and identify the full suite of elements that constitute critical habitats during the HCVF assessment.

Area limited.

The configuration and size of habitat blocks in the boreal mosaic is an important element that contributes to the suitability of conditions for species populations to be maintained. Area limited species may include those that require unfragmented forest interior habitat (*e.g.* barred owl) or large blocks of contiguous forest cover (*e.g.* woodland caribou). Recognizing these habitat blocks as critical habitat and therefore HCVFs may be necessary to sustain meta-populations of area-limited regionally significant species.

SUMMARY OF RECOMMENDATIONS

For the region in which a licence area occurs a set of ecological criteria should be developed to help identify regionally significant species.

Attributes of the collective list of species in the table should reflect:

- All major habitat and forest seral stages occurring in the region, and

A sample of species:
- Whose populations have declined or increased significantly from estimated baseline conditions
- That are resource limited (*e.g.* cavity nesters)
- That are process limited (*e.g.* dependent on natural disturbances such as fire)
- That are dispersal limited (*e.g.* plants, amphibians, reptiles, some invertebrates)
- That are area limited (*e.g.* wide-ranging species, those requiring large blocks of continuous forest cover).

Next, the forest licence area should be assessed for the current or past existence of critical habitat for each regionally significant species.

RANGE EDGE AND OUTLIER POPULATIONS

HIGH CONSERVATION VALUE 1, QUESTION 5

Does the forest support concentrations of species at the edge of their natural ranges or outlier populations?

BACKGROUND

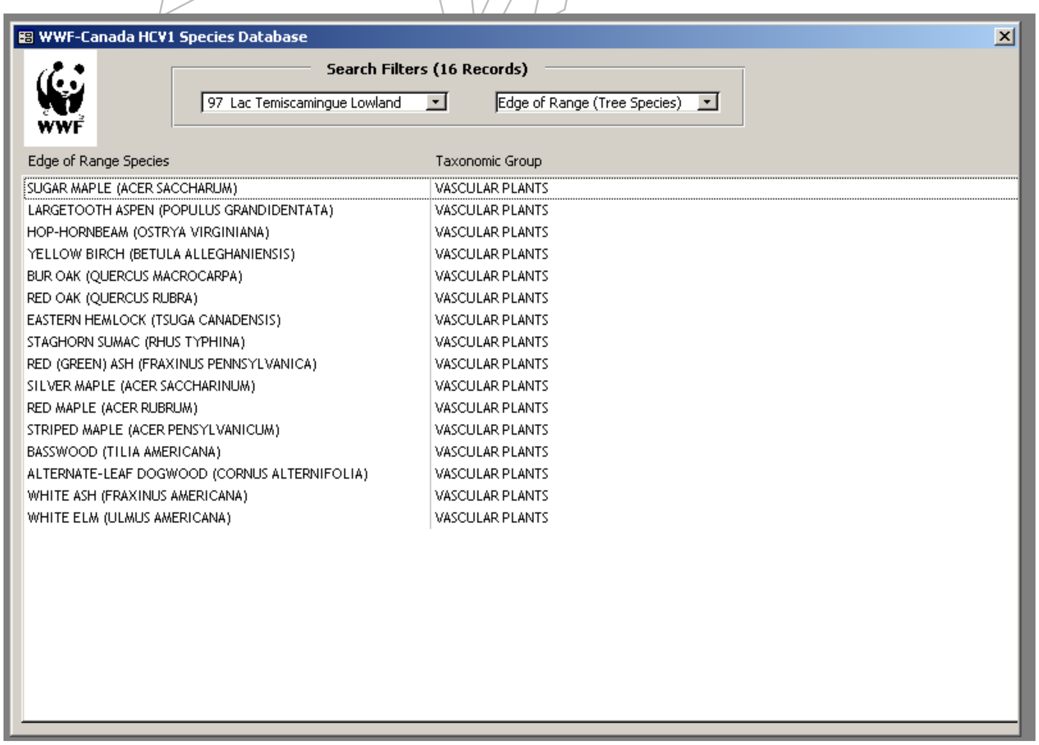
Outlier and edge of range populations of species have long received scrutiny by ecologists, geneticists, plant breeders and conservationists among others. All species have limited distributions at broad geographical scales. At local scales, the distribution of many species is influenced by the interplay of the three factors of habitat availability, local extinctions and colonization dynamics. Gradients in these three factors generate species' range limits and different routes to range limits give rise to distinct spatiotemporal patterns (Holt and Keitt 2000).

Range edge populations are rarely static. Across the boreal forests of North America, many plant and animal species reach their northern range edges in the southern boreal forest while many far northern and Arctic species reach their southern limits in the northern boreal or taiga. In some areas, species ranges are limited by temperature, whereas in others (*e.g.* the western provinces) annual precipitation may be a greater limiting factor than temperature. In some cases, local environmental conditions (climate, soils) may be sufficiently modified to support outlier populations of species disjunct from their main range area. Concentrations of arctic plants along the north shore of Lake Superior are a good illustration of this phenomenon.

In some cases, range edge populations have been shown to harbour more genetic variation or to express more unique genotypes than is characteristic for populations elsewhere in the range. Peripheral populations, which have often adapted to the most extreme environmental conditions across the range as a whole, are also best positioned to be the frontrunners for the species that allow it to adapt to changing environmental conditions. From a conservation perspective, these attributes of range edge populations are important to help guard against potential range contraction (especially for species at risk) and to assist with adaptation to global warming.

Since trees species are a fundamental component of forest stands, contributing significantly to stand biomass as well as to both its structure and function, range edge populations of these species are of particular significance to HCVF assessments. This does not mean, however, that other taxa should be excluded from this type of analysis.

Figure 5.1 Sample output from the WWF-Canada HCV1 species database application.



HCV1 Q5 – Range Edge and Outlier Populations

Data Sources

Multiple sources of information will be required to estimate where range edges occur for many species and it is suggested that qualified ecologists (specialists) be consulted in the preparation of information for this indicator.

In general, field guides, breeding bird atlases, and regional life-science inventories will contain geographic information on local population occurrences or in some cases include regional map ranges which can act as a first approximation or estimation of where range edges occur.

Data sources for digital mapping of species distribution include:

- NatureServe (bird and mammal distributions; see http://www.natureserve.org/getData/birdMaps.jsp http://www.natureserve.org/getData/mammalMaps.jsp)
- Regional CDCs (*e.g.* Ontario Natural Heritage Information Centre; see http://www.mnr.gov.on.ca/MNR/nhic/nhic.cfm)
- USGS Trees of North America (see http://climchange.cr.usgs.gov/data/atlas/little/)
- COSEWIC listed species (see http://www.speciesatrisk.gc.ca/search/speciesResults_e.cfm)

Interpreting the Precautionary Principle

Range edge and outlier populations are often more vulnerable to being lost than range areas where populations are in closer proximity (more connected). This is partly due to the lower probability of adjacent healthy populations being able to provide a 'rescue effect' service (essentially acting as a back-up source) to replenish population numbers in the event of a temporary population decline or loss. This same phenomenon can also be an important consideration for rare species that occur in small populations scattered within a range area or with species whose preferred habitats are widely scattered across the landscape.

For these reasons, species populations that qualify as occurring at their range edge should be identified as HCVs and habitat areas needed to maintain their populations should be recognized as HCVFs. As noted earlier, this will be especially important for forest tree species and the stands in which they occur as forestry activities can alter the competitive interactions and successional processes required to sustain these populations (and possibly other species dependent on their occurrence in the landscape).

Additional Guidance

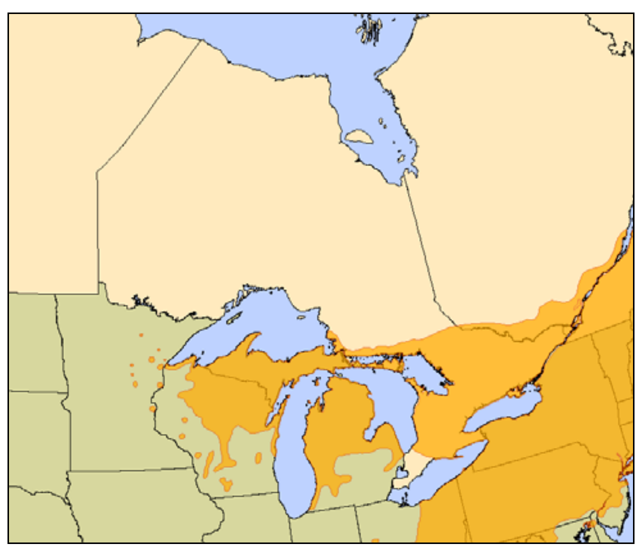
Defining what constitutes a range edge population, versus populations that are characteristic of the main range area for a given species is not an exact science and can be highly scale-dependent. In part, this determination will require (1) an examination of the overall geographic extent of the global range of the species to ascertain, at a coarse scale, if the forest licence area in which the assessment is occurring is approaching or overlapping latitudinal or longitudinal range edges, (2) a more detailed regional examination of the geographic pattern of the species range to assess habitat characteristics associated with population occurrences and (3) at the local level, the degree of connectedness among meta-populations. As a first approximation, we suggest that populations be considered for HCV status when they:

- Represent the outermost 100 km of the known continuous range area [this is very arbitrary… we need to find a defensible number here – maybe a function of the dispersal rate? This would provide a tie to reduced gene flow, which is largely what allows peripheral populations to differentiate]
- Represent relatively narrow, linear extensions of the main range area (*e.g.* along riparian corridors)
- Are reproductively disjunct or isolated from the main range area (the distance between such qualifying populations and the main range area will vary with the species dispersal ability)

If a species is known to be in decline or if it is considered to be a significant species representative of regional habitat types, range edge or outlier populations of these species become especially important to conserve and should be identified as HCVFs.

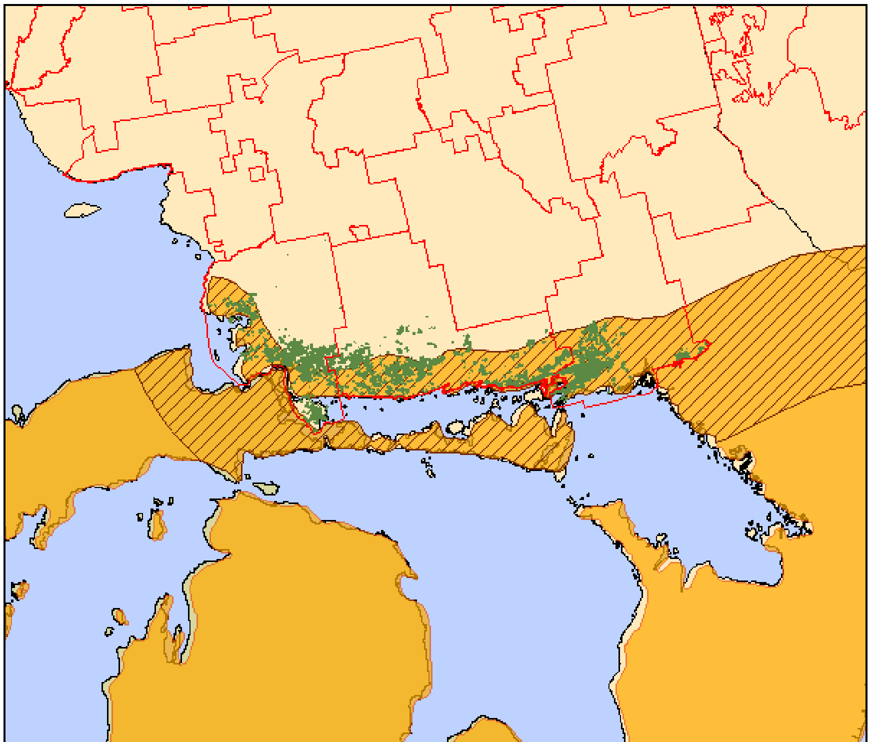
To assist with the identification of range edge and outlier populations that could potentially occur within a forest license area, WWF has assembled a regional look-up table using the framework of the Terrestrial Ecoregions of Canada (Figure 5.1 illustrates sample output for Ecoregion 97, the Lac Temiscamingue Lowland). At this time the table lists only potential tree species populations based on the estimated overlap of species range areas depicted in Hosie (1990). Given the size of the terrestrial ecoregions, the listing of a tree species for that region does not automatically

Figure 5.2 Range of eastern hemlock, *Tsuga canadensis*.



HCV1 Q5 – Range Edge and Outlier Populations

Figure 5.3 Generalized range of eastern hemlock, *Tsuga canadensis*, a 100 km buffer from range edge, and stands containing eastern hemlock in the Algoma, Northshore and Sudbury Forests.



mean that all populations of that species in that region are at their range edge. It does provide guidance, however, for systematically examining all of those tree species that have range edge populations in the region and if these intersect the forest licence area under examination, then they should be listed as HCVs and the stands in which they occur as HCVFs.

In some cases, there may be a need to identify sites as HCVF areas that formerly supported range edge populations of tree species that have declined significantly as a result of past forest practices. An example of this situation pertains to eastern hemlock in the Algoma area in central Ontario. Stands of this long-lived, highly shade-tolerant (and often difficult to re-generate) species have diminished in many parts of its range, including those in this northern part of its range (Figures 5.2 and 5.3). We recommend identifying remaining populations and stands within 100 km of its range edge as HCVFs, with the highest priority being those that are most isolated from adjacent populations. In addition, we recommend that where site conditions exist that could have formerly supported eastern hemlock in the Algoma area, that these be actively managed as HCVFs in a manner that could help restore populations to a level more representative of historical conditions.

Where range edge populations can be maintained under an existing management prescription, sites may still need to be identified as HCVFs in order that monitoring occurs to ensure that management techniques are effective

Summary of Recommendations

Populations that should qualify as range edge under this indicator include those that:

- Represent the outermost 100 km of the known continuous range area
- Represent relatively narrow, linear extensions of the main range area (*e.g.* along riparian corridors)
- Are reproductively disjunct or isolated from the main range area (the distance between such qualifying populations and the main range area will vary with the species dispersal ability)

Where ranges have contracted or where numbers of range edge populations have diminished, site conditions or habitats that could support the re-introduction or restoration of populations should also be considered as HCVFs.

Literature Cited

Hosie, R.C. 1990. Native Trees of Canada, 8th edition. Fitzhenry & Whiteside Ltd.380 pp

Holt, R. and T. Keitt. 2000. Alternative causes for range limits: a metapopulation perspective. Ecology Letters 3 (1): 41-47

CONSERVATION RESERVES

HIGH CONSERVATION VALUE 1, QUESTION 6

Does the forest lie within, adjacent to, or contain a conservation area: a) designated by an international authority, b) legally designated or proposed by relevant federal/ provincial/territorial legislative body, or c) identified in regional land use plans or conservation plans?

BACKGROUND

Documenting protected areas and other conservation reserves would appear to be rather straightforward. However, there are two main issues of confusion. First, it has been debated whether permanent protected areas need to be identified as HCVFs since they are off limits to industrial resource extraction. That is, they are removed from the industrial land base and need not be identified for management or monitoring activities. An alternative position leading to the same conclusion argues that HCVF status should be determined based on the significance and level of threat to the conservation attributes. In this case, the argument is that if no significant threats exist, or if a threat is expected at only low intensity, then the HCV does not need to be formally recognized. The ProForest document and the National HCVF framework are also somewhat inconsistent around this issue. In general, WWF recommends areas should be designated as HCVFs based on the values present, regardless of the existing management or protection status. Management prescriptions and monitoring programs should be considered subsequent to and independent of HCVF identification.

Second, the HCVF framework does not explicitly address the issue of identifying candidate conservation areas to complete a protected areas network. Such candidate areas can be legitimately interpreted as HCVFs if they need to be safeguarded to maintain conservation values until legal protection is confirmed and provided. This is most easily recognized if a protected areas planning exercise has been undertaken and, as an outcome, candidate areas have been identified and documented.

DATA SOURCES

See Table 6.1 below.

INTERPRETING GLOBAL, NATIONAL AND REGIONAL SIGNIFICANCE

Conservation areas can be categorized according to global, national and regional significance (see examples Table 6.1) and thematic maps can show the designations accordingly. For those sites not already included in a legally designated protected area, a site-by-site evaluation is likely required to determine whether attributes comprising the site meet HCVF thresholds. For example, World Heritage sites, RAMSAR sites and Biosphere Reserves will likely meet HCVF thresholds since rigorous criteria are used in their identification and designation. International Biological Program sites, on the other hand, were identified as representative or significant examples of habitat types or ecosystem dynamics and may not always meet HCVF thresholds. Similarly, candidate protected areas identified by various conservation agencies or regional planning authorities need to be evaluated to determine if HCVF thresholds are met.

ADDITIONAL GUIDANCE

Are the conservation areas recognized in government legislation or policy?

Table 6.1 Examples of conservation area designations of global, national and regional significance and data sources.

DESIGNATION	SIGNIFICANCE
World Heritage Sites[1]	International
Wetlands of international importance[2]	International
World Biosphere Reserves[1]	International
International Biological Program sites[5]	International
National Parks and Heritage Sites[3,6]	National
Migratory Bird Sanctuaries and National Wildlife Areas[4,6]	National
Provincial Parks and Ecological Reserves[6]	Provincial
Environmentally Significant Areas[7,*]	Provincial/Regional
Candidate protected areas[8]	Provincial/Regional

1. UNESCO: http://www.unesco.org/
2. RAMSAR: http://www.wetlands.org
3. Parks Canada
4. Canadian Wildlife Service, Environment Canada
5. Conservation Data Centres
6. CARTS – Conservation Areas Reporting and Tracking System
7. Regional or municipal land use plans
8. Government parks or wildlife agencies or non-government conservation agencies.

* Examples of ESAs include Areas of Natural and Scientific Interest (ANSIs) in Ontario, significant woodlands, significant wetlands, water source protection areas, special features protection areas for old growth and/or unique phenomenon.

HCV1 Q6 – Conservation Reserves

In the past, WWF has recommended that legally protected areas and conservation areas with a clear policy basis related to biodiversity protection should be automatically identified as HCVFs. This argument was based on the need to be consistent in addressing landscapes that are not part of the forest management land base.

This interpretation differs from the intent of the guidance in both the ProForest HCVF toolkit and the National HCVF framework in which conservation areas judged to be effective for biodiversity protection (*e.g.* with legal protection) need not be designated as HCVFs. WWF also recognizes arguments that the focus of the HCVF designation should be on the conservation attributes and not necessarily on the designation of a site. As a result, we do not feel the need to continue the recommendation that legally protected areas are automatically HCVFs.

However, it is important that all conservation areas are identified, mapped, and evaluated for HCVs in order to identify possible adjacent or connecting habitats, and to ensure that any HCVs within the protected areas are recognized, maintained or enhanced (Figure 6.1). The specific guidance provided in the National HCVF framework addresses the presence or absence of HCVs, habitat connectivity, and buffer areas for existing PAs. Although this likely requires a site-by-site evaluation of the relevant conservation attributes, some categories of parks may be efficiently removed from screening if the purpose of the designation is more related to recreational opportunities rather than biodiversity conservation.

For conservation areas of interest not recognized by legislation or policy, it is recommended that each site or category of sites be evaluated for consistency with other aspects of the HCVF framework to determine HCVF status (Figure 6.2), especially in cases where protected areas networks are likely to be added to our completed in the near future. Examples include:

- Environmentally Significant Areas (ESAs) in Alberta. Al-Pac, in their HCVF Summary document, selected to interpret ESAs under Question 11 (regionally/nationally significant forest ecosystems), although these could be considered under Question 6.
- Class 1-3 wetlands in Ontario.
- Designated old growth red and white pine sites in Ontario.
- Hazard lands identified in regional land use plans. These areas may also be evaluated under the HCV4 questios (*i.e.* basic services of nature).

Figure 6.1 Legally designated conservation areas from which industrial activity is excluded.

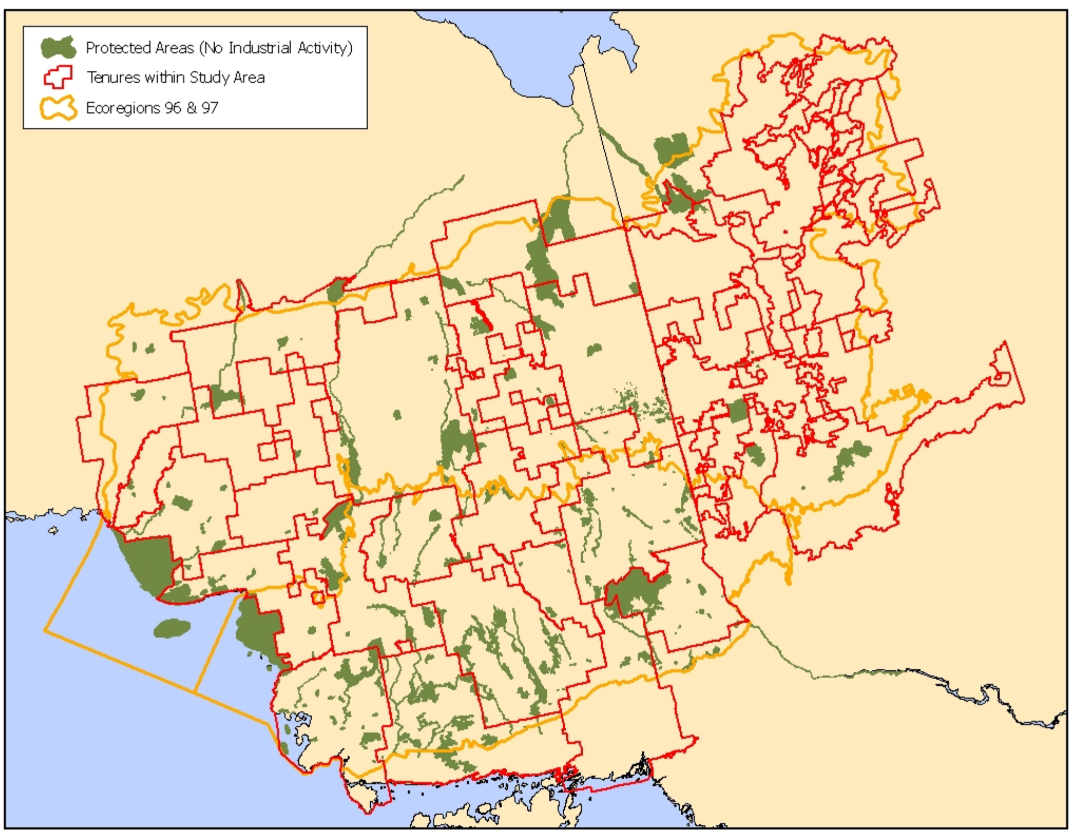
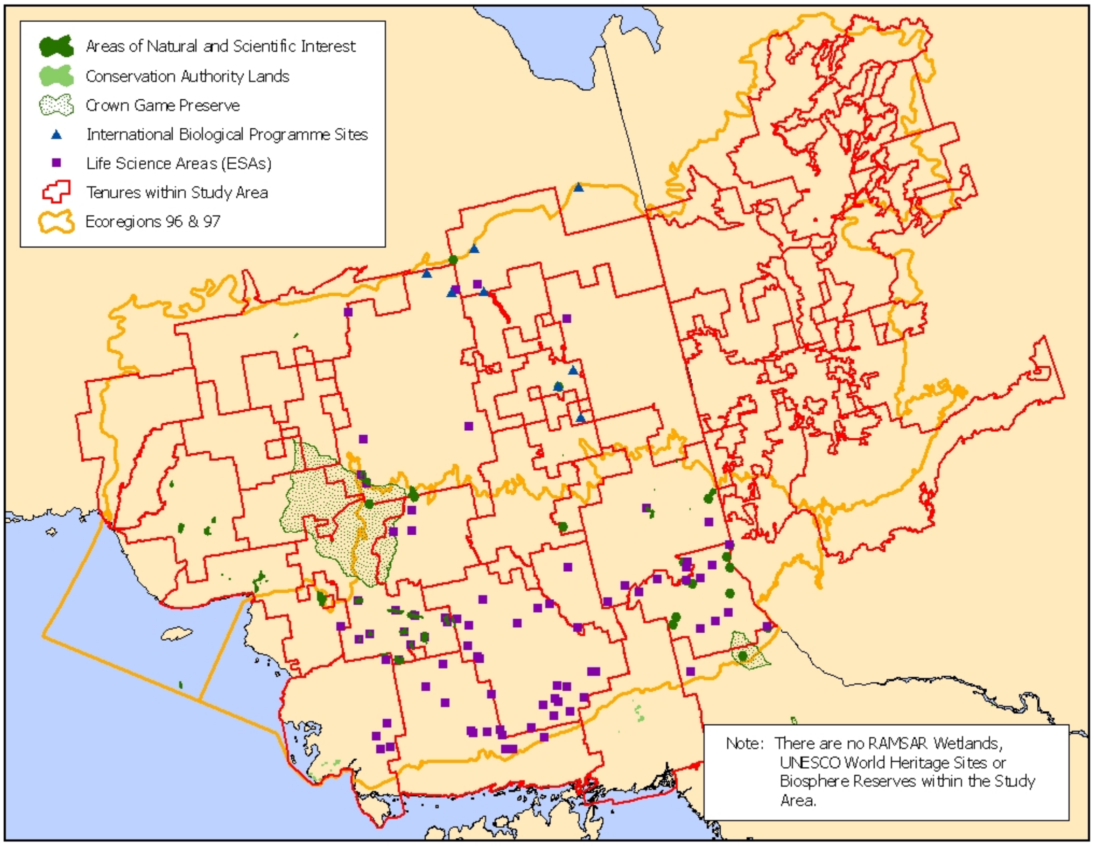


Figure 6.2 Conservation areas identified through scientific and land-use studies and recognized in government policy.



- Natural heritage designations in regional land use plans. These areas are not legally protected, but are usually identified because of environmental sensitivity. Areas should be treated on a case-by-case basis.

Are there features that occur in the forest that are not represented in the protected areas network (representation gaps)?

A simple quantitative analysis can be undertaken to measure the extent to which ecological features are represented in protected areas – ideally, a known gap analysis methodology can be applied. In cases where the protected areas network is largely incomplete from this perspective, it is strongly recommended to engage in an appropriate protected areas planning or conservation planning exercise with relevant stakeholders. Features or attributes that are unique and not represented in the protected areas system are best addressed through HCV3. Common or widespread features that are not adequately represented are best identified as potential HCVs until further analysis identifies best options for protection. Identification of these candidate protected areas can be greatly informed by HCV investigations in general, and spatial overlay suggested in Question 19, specifically.

For example:

- Deferral areas identified using a gap analysis to meet the requirements of Criterion 6.4.

SUMMARY OF RECOMMENDATIONS

It is recommended in response to this question that all designated and identified areas derived from, but not limited to, the sources listed in Table 6.1 above should be shown on a map.

Legally protected areas and conservation areas with clear policy basis and effective biodiversity protection mechanisms do not *need* to be identified as HCVFs. However, each should be evaluated for HCVs. Consideration of the distribution of protected areas together with other conservation areas may also identify significant opportunities for conservation network connectivity.

For conservation areas of interest not recognized by legislation or policy, it is recommended that each site or category of sites be evaluated for consistency with other aspects of the HCVF framework to determine HCVF status.

HCV1 Q6 – CONSERVATION RESERVES

It is recommended that a measure of protected areas completion (*i.e.* gap analysis results) be illustrated and include a discussion of types of areas and/or features required to complete representation. If candidate protected areas have been previously identified (such as deferral areas through Criterion 6.4), then these sites should be designated as HCVFs until confirmed as protected areas through an appropriate land use planning exercise.

Lack of representation alone is not a criterion for HCV status. However, in cases where the protected areas network is mostly incomplete from this perspective, then it is strongly recommended to engage in an appropriate protected areas planning or conservation planning exercise with relevant stakeholders. In addition, Question 19 is intended to look at the spatial coincidence of HCVFs. Assessing the level of spatial coincidence of HCVFs with unrepresented features will assist in defining candidate protected areas in the absence of such an exercise having been completed. Therefore, we recommend that a completed HCVF assessment and, in particular, the guidance offered in Question 19, can be used as part of a conservation planning effort to complete a network of protected areas.

METHODOLOGY

<u>Figures 6.1 and 6.2</u>

Data Sources

- WWF-Canada. Designated Areas Database
- CCEA. Canadian Conservation Areas Database (CCAD)
- OMNR. Natural Resource Value layers
    - o Regulated Provincial Parks layer
    - o Regulated Conservation Reserves layer
    - o Crown Game Reserves layer
    - o Conservation Authority Lands layer
    - o ANSI layer
- Ontario Natural History Information Centre (NHIC)
    - o ANSI-ES Sites
    - o ANSI-LS Sites
    - o ANSI-LSC Sites
    - o Life Sciences (ESA) Sites
    - o International Biological Programme (IBP) Sites
- Global Forest Watch. Forest Tenures in Canada.
- Terrestrial Ecoregions of Canada.

Methodology

- All data was clipped to the study area boundaries (Terrestrial Ecoregions of Canada 96 and 97) and displayed without modification
- Figure 6.1 illustrates all protected areas identified as free of industrial development by the WWF-Canada Endangered Spaces project, as well as more recent data obtained from OMNR
- Figure 6.2 illustrates the sum total of ANSI, ESA, Conservation Authority Lands and IBP Sites, including the Chapleau Crown Game Preserve identified by NRVIS, NHIC, and CCAD.

LARGE AND REMNANT LANDSCAPE LEVEL FORESTS

HIGH CONSERVATION VALUES 2 & 3, QUESTIONS 7 & 10

Does the forest constitute or form part of a globally, nationally or regionally significant forest landscape that includes populations of most native species and sufficient habitat such that there is a high likelihood of long-term species persistence?
Are large landscape level forests (i.e. large unfragmented forests) rare or absent in the forest or ecoregion?

BACKGROUND

The intent of Question 7 is to identify intact or relatively intact contiguous forest landscapes of a size such that there is a likelihood of longer-term persistence of native species (*i.e.* 10s to 100s of years). There are two main areas of investigation for which guidance is provided in the national HCVF framework: size of unfragmented forest landscapes and habitat condition. Thresholds for these two indicators will likely differ for broad forest ecosystem types. Furthermore, the investigation of forested landscapes should consider more than just the forest stands. That is, all natural, non-forest habitat (*e.g.* wetlands), water bodies and naturally disturbed areas (burns, insect damage, windthrow areas) can be part of a large landscape level forest.

In highly fragmented forest regions where large functioning landscape level forests are rare or do not exist, many of the remnant forest patches require consideration as potential HCVs under Question 10. These are the "best of the rest" areas – remnant patches that may:

- Provide the only remaining habitat for some forest species on a local or regional scale
- Serve as important source areas for recolonization of species
- Serve as representative areas informally within a landscape or formally with a protected areas network.

Similar analyses can be used to address both Questions 7 and 10, hence these are dealt with together in this document. The main issues pertaining to functional intactness, including type and density of human infrastructure, adjacency and linkages, and forest quality also apply to both investigations. Additional issues to consider under Question 10 include the size and scale of the remnant patches, the distribution of these patches in the landscape, and quality of forest in these patches.

DATA SOURCES

In general, we recommend that this analysis consider permanent infrastructure (*e.g.* road and rail lines, power transmission corridors), non-permanent human disturbances (*e.g.* harvest areas, logging roads, seismic cut lines), and indicators of forest condition (*e.g.* seral stage distribution, focal species habitat availability).

The HCVF Framework for Canada lists the following possible data sources:

- Global Forest Watch (GFW) Large Remaining Unfragmented Forest Areas dataset (http://www.globalforestwatch.ca/)
- Forest cover, infrastructure, and disturbance data provided by industry or government

Additional data sources which could inform analyses of forest quality might include:

- Data from forest cruises on stand structure
- Significant species and habitat distribution (see suggested significant species list under HCV 1, Question 4 in this document)
- Community and seral stage distribution data from Forest Resource Inventory data.

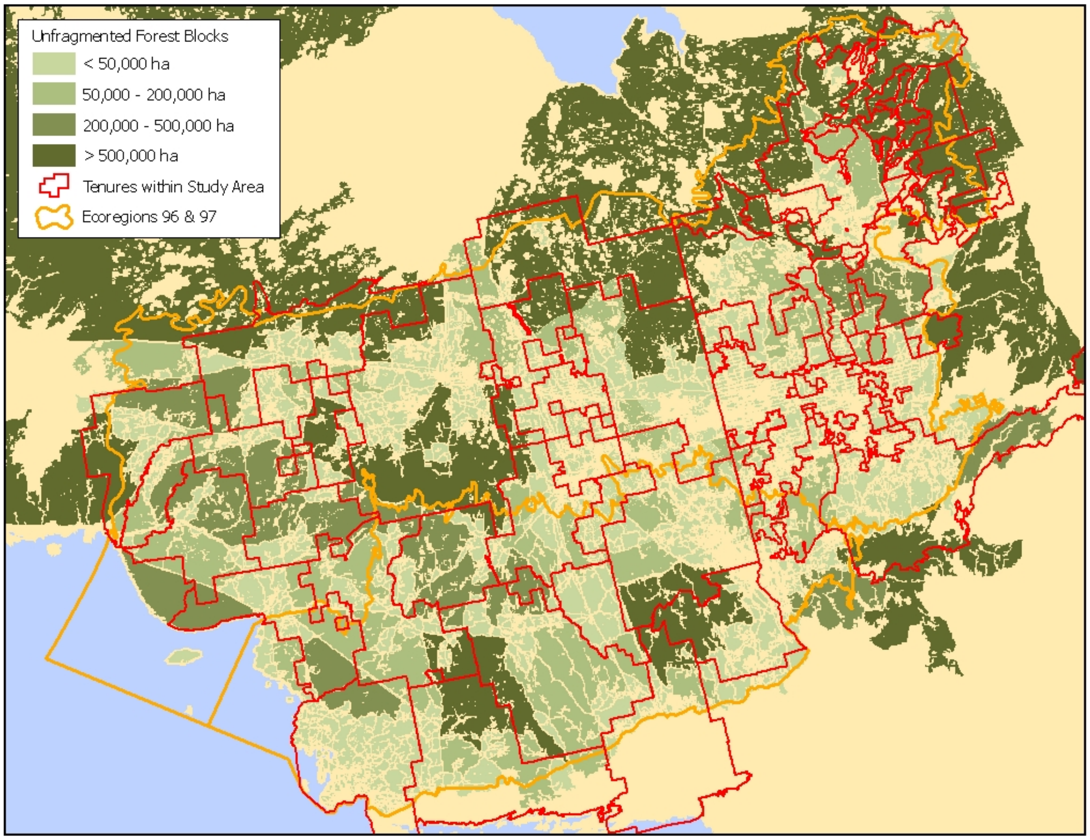
The methods laid out below utilize permanent infrastructure as delimiters of forest blocks, and non-permanent, anthropogenic disturbances (e.g. non-permanent roads, cutovers) as indicators of forest quality. The newest data from GFW (2005) utilize all disturbances, both permanent and non-permanent, to define intact forest landscapes, resulting in a very restricted set of areas. For this reason, the analyses below have used the 2001 version of the GFW Large Remaining Unfragmented Forest Areas, which is based only on permanent infrastructure, allowing non-permanent disturbance to be considered independently.

INTERPRETING GLOBAL, NATIONAL AND REGIONAL SIGNIFICANCE

The national HCVF framework has suggested thresholds for globally (greater than 500,000 ha), nationally (200,000 to 500,000 ha) and regionally (50,000 to 200,000 ha) significant large landscape level forests for boreal ecosystems. These thresholds are generally based on fire disturbance dynamics and habitat requirements for wide-ranging species. For other broad forest ecosystems, such as Pacific maritime, montane Cordilleran and Acadian forests, the thresholds will need to be modified to reflect the spatial and temporal scales of disturbance-recovery events and wildlife movements. One source of information to determine the size thresholds for other forest ecosystems is the WWF documentation related to the Assessment of Representation GIS tool (ftp://forests:gc678yy@ftp.wwf.ca/).

Thresholds for forest condition attributes also change for broad forest ecosystems. Frequency distributions of fire sizes and other analyses suggest that more that 30% late seral stands comprise more natural forests in

Figure 7.1 Large landscape level forests intersecting the study area.



eastern boreal landscapes (Bergeron *et al.* 1998). In drier western boreal forest landscapes, 10% late seral stand composition is more common (Lee *et al.* 2000; Johnson *et al.* 1995). We would also suggest that the need to consider indicators of habitat condition diminishes as the size of unfragmented forest landscape approaches thresholds that are considered globally significant. For example, a natural forest landscape in excess of 500,000 ha in size with appropriately low levels of human disturbance should be identified as an HCVF even though it may contain less than an appropriate amount of late seral, potentially as a result of recent large fires burns.

In landscapes where large landscape level forests are rare or absent, it is recommended to examine intact forest remnants at a broad regional scale such as the ecoprovince or North American ecoregion to assess the relative significance of forest patches.

ADDITIONAL GUIDANCE

We suggest two approaches to identifying large or remnant landscape level forests. One approach uses all permanent infrastructure to map intact forest blocks, and to then consider non-permanent human disturbances and forest condition measures. A complementary approach uses watersheds as the geographic unit to compile permanent infrastructure and non-permanent disturbance data as well as other measures of forest condition.

Map unfragmented forest landscapes and consider the level of non-permanent human disturbances

This analysis should first be conducted at the regional scale, as shown in Figure 7.1, using information that is of a consistent level of detail across forest tenures. This will emphasize areas of particular significance in the broader region that includes the forest tenure under investigation. In Figure 7.1, seven general areas of globally or nationally significant large landscape level forests are evident: two in Quebec and five in Ontario. However, this assessment does not necessarily confirm the presence of large landscape level forests. Consideration needs to be given to measures of forest condition within these blocks.

Analysis of forest condition is addressed through analyses scaled down to the level of the tenure, in this case Iroquois Falls Forest (Figure 7.2). Intact forest blocks are further refined using the best quality permanent infrastructure data available, and the degree of anthropogenic, non-permanent disturbance can be tabulated for each block (Table 7.1). While four forest blocks meet the minimum 50,000 ha threshold for a large landscape level forest (LLLFs 9, 10, 21 and 26), none of these forests meet the 5% disturbance threshold suggested in the HCVF framework. This

Figure 7.2 Distribution of unfragmented forest blocks within Iroquois Falls Forest (ID numbers relate to Table 7.1)

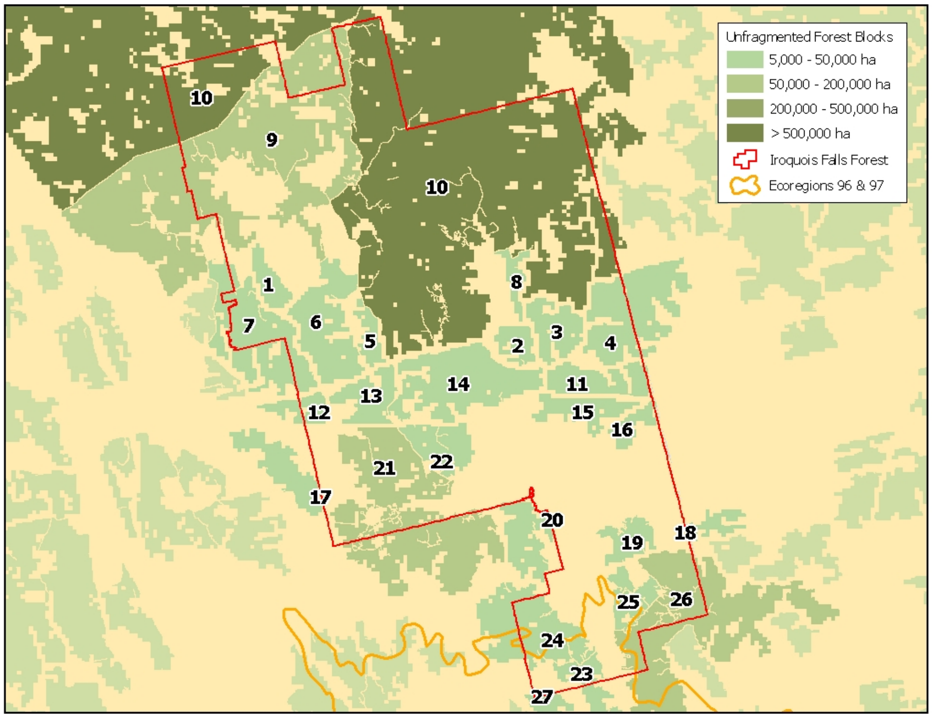
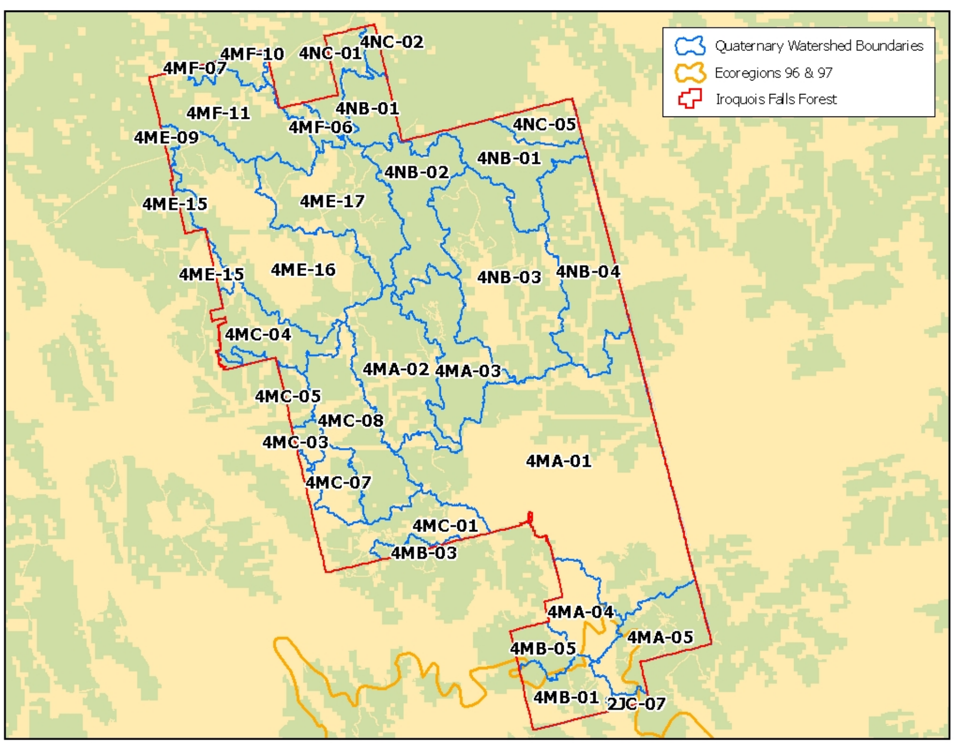


Figure 7.3 Quaternary watersheds within Iroquois Falls Forest (Watershed IDs relate to Table 7.1)



straight comparison should be tempered with an understanding of the limitations of the analyses. In this case, only disturbance within the tenure in question has been analyzed. Forest block 10, while containing disturbance well in excess of the recommended threshold, is connected to a much vaster tract of forest outside the tenure, and is in all likelihood connected to unallocated forest further to the north. This forest block should be considered a HCVF despite the nominal violation of the disturbance threshold.

It is common that the result of a regional scan of large forest blocks will differ from the finer grained investigation at the level of the individual tenure. Regional investigations suggest that the Gordon Cosens Forest (GCF) includes parts of two globally significant large landscape level forests while a nationally significant large landscape level forest comprises much of the Pineland-Martel Forest (PMF). However, in separate HCVF assessments using more detailed roads data and non-permanent human disturbances, the large landscape level forests are reduced in the GCF to smaller, regionally significant large landscape level forests and are non-existent in the PMF. This results from a consideration of non-permanent disturbances which exceed the suggested 5% threshold. Cases such as this, where a regional scan indicates the presence of large landscape level forests but a tenure level analysis diminishes or eliminates forest blocks, can potentially reveal the best opportunities to select remnant intact forest blocks under Question 10.

Investigate the density and/or proportion of disturbances and forest condition attributes for watersheds

A complementary analysis considers comparing statistics for permanent infrastructure, non-permanent human disturbances and select forest quality indicators within watersheds. Figure 7.2 and Figure 7.3 illustrate the distribution of unfragmented forest landscapes and watersheds, respectively, for the Iroquois Falls tenure.

In Table 7.1, we used the following thresholds to identify potential large landscape level forest HCVs for watersheds intersecting the Iroquois Falls forest tenure:

- density of permanent infrastructure <0.05 km/km^2 (Noss 1995)
- proportion of non-permanent disturbances <5%. This threshold is provided in the national HCVF framework. McIntyre and Hobbs (1999) defined intact landscapes as retaining 90% of natural or near-natural habitat (*i.e.* with a low degree of modification).
- proportion of late seral forests >30% (Bergeron *et al*. 1998).

This assessment identifies six highly likely watersheds as large landscape level forests (4ME-09, 4MF-07, 4MF-10, 4MF-11, 4NB-02, 4NC-02) and four additional watersheds (4MF-06, 4NB-01, 4NB-04, 4NC-05) as possible HCVs.

There are several observations that we can make and we have thematically depicted the selected watersheds in Figure 7.4 to illustrate some points:

- The selected watersheds in this case are contiguous. Using all watersheds results in one regionally significant (77,000 ha) and one nearly nationally significant (193,000 ha) large landscape level forest. Note that we have data for only parts of some watersheds and it would be ideal to have the results for all parts of all intersecting watersheds. In fact, these watersheds may be contiguous with the intact, unallocated forest and, hence, would be considered globally significant.
- If the marginal watersheds (4NC-05 and 4NB-04) are removed, then this drops the nationally significant forest to a regionally significant large landscape level forest.
- Considering only the six most likely intact watersheds listed above still results in two regionally significant large landscape level forests. Note that the human disturbance and habitat condition indicators for most of the watersheds are very close, but not all within *a priori* thresholds set out above. Given the nature of deriving HCV thresholds, we feel that this type of subjective judgment is credible with an appropriate rationale.

Comparison of analyses of unfragmented forest blocks to forested watersheds

The analysis of unfragmented forest blocks will, by definition, capture large blocks of contiguous forested landscapes. These relatively intact expanses are of importance in maintaining large-scale natural disturbance regimes and as habitat for wide-ranging species and species that are sensitive to the barriers to migration which permanent infrastructure often represents (Noss & Csuti, 1997). An analysis of watersheds is based on ecological units within the landscape and is appropriate because the level of intactness of forest cover plays a role in the ecological functiona of watersheds (Bosch & Hewlett 1982; Hornbeck *et al*. 1993).

While in the case of Iroquois Falls Forest, the two methods identify largely complimentary results (Figure 7.5), some key differences are seen which illustrate the strengths and weaknesses of both approaches.

The analysis of unfragmented forest block is highly sensitive to any permanent infrastructure, and can result in the subdivision of otherwise large intact, forested landscapes into less substantial blocks due to the dissection of a single road or hydro corridor. This can be seen in Figure 7.2, where LLLF 9 and 10 are separated in the northwest corner of the tenure by a single corridor. The watershed-based analysis does not reveal this division, rather it identifies a watershed with very low levels of disturbance and high indicators of quality.

The watershed-based approach is susceptible to diminishing the area identified as intense, localized disturbance in one portion of a large watershed can remove the entire watershed from the analysis. This results in the “buffered” appearance of Figure 7.5,

Table 7.1 Summary of forest block and watershed size and condition in Iroquois Falls Forest

	BLOCK ID	AREA OF BLOCK WITHIN TENURE (HA)	TOTAL BLOCK SIZE (HA)	DENSITY OF PERMANENT DISTURBANCE WITHIN TENURE (KM/KM^2)	PROP. OF NON-PERMANENT DISTURBANCE WITHIN TENURE	PROP. OF LATE SERAL STANDS
LARGE LANDSCAPE LEVEL FORESTS	LLLF 1	7,710	7,710		0.1%	17.5%
	LLLF 2	6,755	6,755		30.4%	12.6%
	LLLF 3	13,717	13,717		28.3%	10.0%
	LLLF 4	19,032	40,180		0.7%	5.2%
	LLLF 5	5,851	5,851		20.0%	4.4%
	LLLF 6	30,253	30,253		12.3%	12.1%
	LLLF 7	22,402	42,215		11.4%	10.8%
	LLLF 8	5,314	5,314		57.6%	10.9%
	LLLF 9	86,968	170,091		18.6%	34.2%
	LLLF 10	320,157	2,561,259		12.9%	25.5%
	LLLF 11	15,069	15,362	*N/A*	2.5%	1.1%
	LLLF 12	3,937	7,166		1.4%	8.6%
	LLLF 13	12,720	12,720		10.5%	15.0%
	LLLF 14	40,723	40,723		2.1%	9.2%
	LLLF 15	12,160	12,160		13.7%	3.6%
	LLLF 16	5,860	5,989		6.1%	2.2%
	LLLF 19	9,356	9,356		6.3%	5.2%
	LLLF 20	546	15,908		28.5%	32.0%
	LLLF 21	43,254	85,246		15.3%	12.3%
	LLLF 22	14,590	14,590		11.9%	15.7%
	LLLF 23	5,060	11,789		11.1%	0.7%
	LLLF 24	20,159	36,452		28.5%	6.9%
	LLLF 25	9,996	9,996		22.1%	5.3%
	LLLF 26	25,767	83,490		16.5%	5.0%
	LLLF 27	491	8,034		7.0%	14.3%
QUATERNARY WATERSHEDS	4MA-01	244,219		0.28	11.1%	4.5%
	4MA-02	59,034		0.34	12.2%	6.3%
	4MA-03	44,873		0.19	5.7%	10.1%
	4MA-04	26,292		1.02	15.6%	3.0%
	4MA-05	37,950		0.54	21.8%	4.8%
	4MB-01	25,842		0.61	24.2%	4.3%
	4MB-03	4,248		0.53	33.0%	0.0%
	4MB-05	13,236		0.46	22.4%	7.1%
	4MC-01	41,757		0.64	29.0%	5.4%
	4MC-03	6,576		0.44	9.1%	13.8%
	4MC-04	31,436		0.29	10.8%	11.7%
	4MC-05	10,080		0.37	3.1%	11.0%
	4MC-07	16,314	*N/A*	0.46	27.8%	16.0%
	4MC-08	51,905		0.25	13.6%	13.2%
	4ME-09	3,795		0.10	5.3%	40.3%
	4ME-15	6,917		0.20	38.9%	22.5%
	4ME-16	109,186		0.28	36.8%	17.9%
	4ME-17	63,953		0.24	32.3%	17.4%
	4MF-06	7,345		0.08	8.2%	20.3%
	4MF-07	2,786		0.00	0.0%	37.0%
	4MF-09	161		0.00	0.0%	28.9%
	4MF-10	6,308		0.12	0.0%	33.7%
	4MF-11	56,820		0.06	3.0%	37.4%
	4NB-01	59,828		0.03	12.1%	38.0%
	4NB-02	46,728		0.04	6.0%	30.8%
	4NB-03	101,997		0.30	34.4%	17.9%
	4NB-04	66,941		0.11	8.4%	16.3%
	4NC-01	16,083		0.27	25.9%	17.2%
	4NC-02	4,185		0.08	5.8%	25.3%
	4NC-05	15,347		0.00	13.2%	17.9%

where the areas identified by the watershed approach are withdrawn from the margins of the areas identified by looking at large forest blocks.

Using the summed areas of both lines of investigation gives a more comprehensive view of large landscape level forests, and those areas identified by both approaches are highlighted as being of prime importance.

Size and scale of remnant large landscape level forests

The HCVF Framework refers to remnant patches that are "thousands of hectares" in size, but does not provide further guidance on determining how large a remnant should be to qualify as a HCVF under Question 10. The significance of a remnant is scale dependent – that is, relative to the size of the landscape and to other forest patches. Within smaller block sizes, other factors including forest condition and quality and proximity to other landscape features (see below) increase in importance for determining HCVF status. As with Question 7, thresholds for the two primary indicators - remnant patch size and forest condition – will likely differ for different forest ecosystem types.

Quality of forest remnants

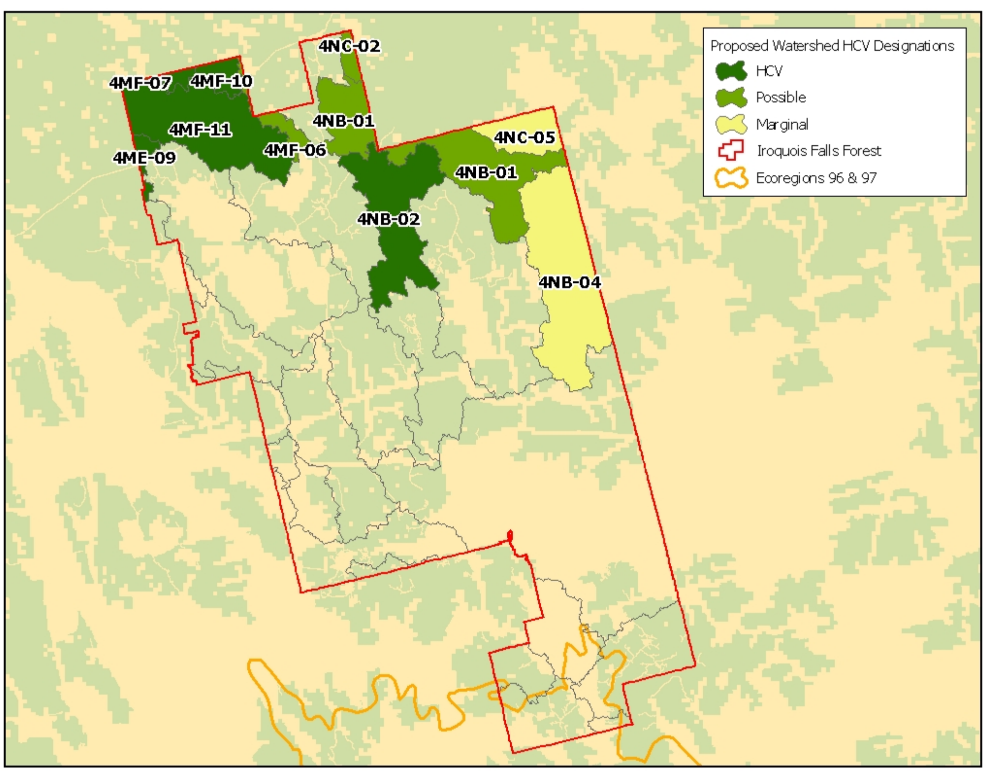
The guidance questions in the HCVF Framework recognize the importance of several forest quality parameters in determining HCVF status on forest remnants. One factor that is sometimes overlooked is that natural disturbance cycles are an important part of intact forest landscapes; forests affected by wild fire, insects or windthrow may still be intact, even if the canopy layer is removed or compromised. In addition to levels of anthropogenic disturbance, we recommend investigation of the following indicators of forest quality during the HCV assessment process:

- Percent of climax species vs pioneer species Thresholds for forest condition attributes depend on the characteristics of the broad forest ecosystem. Frequency distributions of fire sizes and other analyses suggest that natural eastern boreal forests are composed of approximately 30% late seral stands (Bergeron *et al*. 1998). In drier western boreal forests landscapes, a 10% late seral stand composition is common (Lee *et al*. 2000; Johnson *et al*. 1995).
- Habitat for focal species – a cumulative effects study conducted for the Deh Cho Land Use Planning Committee (2004) provides well-researched thresholds for habitat availability, minimum core area, minimum patch size, and specialized habitat features. We recommend this type of approach for evaluating habitat quality for focal species.
- Structural indicators
    - Number of snags/hectare
    - Amount of coarse woody debris
    - Forest cruise data on canopy structure

Distribution of forest remnants on the landscape

How and if relatively large remnant patches are

Figure 7.4 Proposed HCV status of quaternary watersheds based on levels of disturbance.



connected to natural corridors (*e.g.*, rivers with buffers) is significant for wildlife and the functioning of natural disturbance regimes. An analysis of the distribution of relatively large remnant forest patches relative to other landscape features should help in determining local and regional significance.

The question of distribution on the landscape can be also be addressed by taking the previously discussed alternative approach of looking at high quality watersheds as the base unit of "forest blocks" and looking at connectivity of these high quality watersheds in the landscape (Figure 7.3; Table 7.1).

If we look at the analysis for Iroquois Falls Forest and work under the assumption that no Large Landscape Level Forests were identified (*i.e.* assume that LLLFs 9 & 10, and watersheds 4ME-09, 4MF-6, -7, -10, and -11 are omitted; see Figures 7.2 and 7.3), then we can use this data as an illustrative example for discussion of forest remnants using the same thresholds:

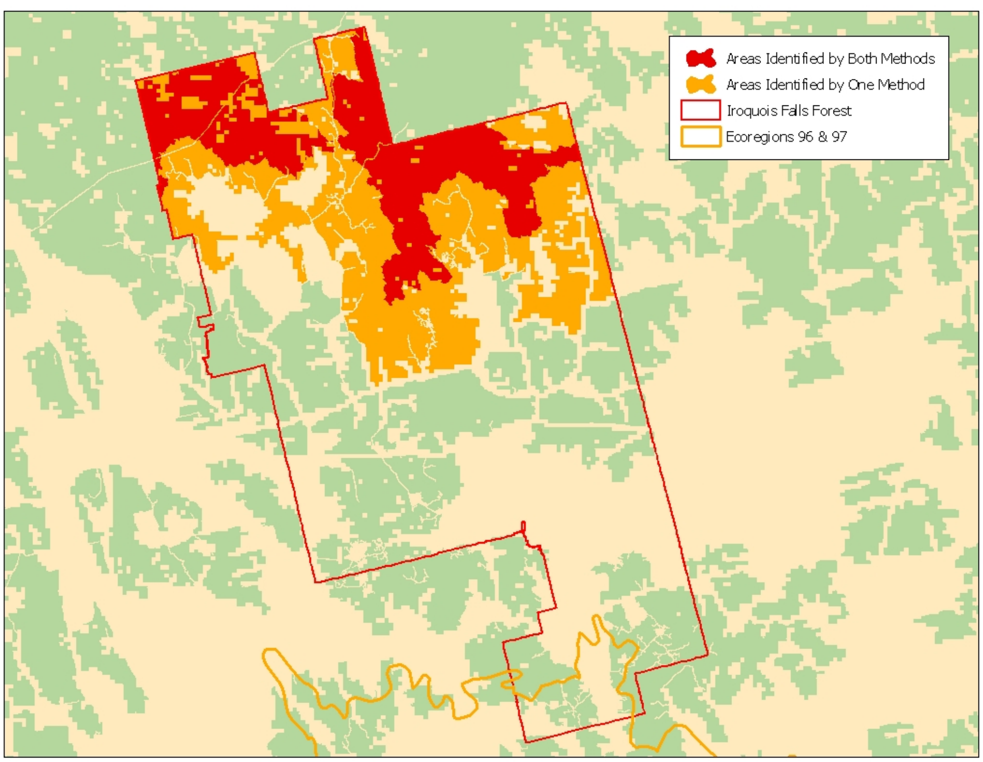
- density of permanent infrastructure <0.05 km/km^2 (Noss 1995)
- proportion of non-permanent disturbances <5%. This threshold is provided in the national HCVF framework. McIntyre and Hobbs (1999) defined intact landscapes as retaining 90% of natural or near-natural habitat (*i.e.* with a low degree of modification).
- proportion of late seral forests >30% (Bergeron *et al.* 1998)

Given that no forest blocks or watersheds meet these thresholds, the "best of the rest" approach leads those closest to the thresholds to be selected. For the Iroquois Falls example, if the thresholds are relaxed to consider watersheds with 0.3 to 0.5 km/km2 road density, less than 10% non-permanent disturbance and greater 10% late seral stands, five watersheds are selected: 4MC-05, 4MA-03, 4MC-03, 4MC-04 and 4MC-08. Using the same thresholds for remnant forest blocks, we would select LLLF 13 and 22.

Watershed 4MF-09 and LLLF 27 would also techinically qualify under these thresholds, but only a very small portion of these blocks intersects Iroquois Falls Forest. Levels of disturbance outside the tenure boundaries are unknown. If these small blocks were connected to much larger, high quality areas outside the tenure, then these blocks could be additionally selected.

A survey of the spatial arrangement of the watersheds, and their levels of disturbance suggests that the contiguous unit formed by watersheds 4MC-04, 4MC-05 and 4MC-08 captures a contiguous area with moderate levels of permanent and non-permanent disturbance, proportions of late seral forest which are on par with the surrounding forest blocks, and which encompasses several sizable forest remnants.

Figure 7.5 Comparison of results from the forest block and watershed approaches to identifying large landscape level forets in Iroquois Falls Forest.



HCV2/3 Q7/10 – LARGE AND REMNANT LANDSCAPE LEVEL FORESTS

We recommend the following questions as additional guidance in determining remnant forest blocks

- If remnant patches are dominated by pioneer species, did this condition result from a natural or anthropogenic disturbance events? (See discussion of forest quality above.)
- Are intact remnants connected to or in close proximity to other important habitat features on the landscape (*e.g.*, river corridors)?

SUMMARY OF RECOMMENDATIONS

- Examine large landscape level forests and remnants at multiple scales to reveal their relative significance.
- Investigations should consider the size and condition of forest blocks, as per the HCVF framework, but should also utilize the watershed-based approach. The combined results of these two analyses will address a broader definition of intact forest landscapes.
- To determine HCVF status under Question 10 weigh and balance stand quality with patch size and proximity. Higher quality remnants that are well positioned on the landscape relative to other HCVs are usually good candidates for HCV status.
- Percent of climax vs pioneer species, habitat for focal species, and structural habitat indicators should all be used as indicators of forest quality.

LITERATURE CITED

Bergeron, Y., P. Richard, C. Carcaillet, S. Gauthier, M. Flannigan and Y. Prairie. 1998. Variability in fire frequency and forest composition in Canada's southeastern boreal forest: a challenge for sustainable forest management. Conservation Ecology (http://www.consecol.org/vol2/iss2/art6)

Bosch, J.M. and J.D. Hewlett. 1982. A review of catchment experiments to determine the effect of vegetation changes on water yield and evaportranspiration. J of Hydrology. 55:3-23.

Deh Cho Land Use Planning Committee. 2004. Online: http://www.dehcholands.org/reports_cumulative_effects_report.htm.

Hornbeck, J.W., M.B. Adams, E. Corbett, E. Verry, J. Lynch. 1993. Longterm impacts of forest treatments on water yield: a summary for northeastern USA. J. of Hydrology 150:323-344.

Johnson, E., K. Miyanishi, J. Weir. 1995. Old growth, disturbance, disturbance and ecosystem management. Canadian Journal of Botany 73: 918-926.

Lee, P., S. Hanus and B. Grover. 2000. Criteria for estimating old growth in boreal mixedwoods from standard timber inventory data. Forest Ecology and Management 129: 25-30

McIntyre and Hobbs. 1999. A framework for conceptualizing human effects on landscapes and its relevance to management and research models. Conservation Biology 13:1282-1292

Noss, R. 1995. Maintaining ecological integrity in representative reserve networks. WWF-Canada/WWF-US Discussion Paper.

Noss, R. and B. Csuti. 1997. Habitat fragmentation. In G. Meffe and C. Carroll (eds). Principles of Conservation Biology, 2nd Ed. Sinaeur Associates.

Uhlig, P., G. Craig, C. Bowling, B. Chambers, B. Naylor and G. Beamer. 2001. Old growth forest definitions for Ontario. OMNR, Queen's Printer for Ontario, Toronto, ON.

METHODOLOGY

Figures 7.1, 7.2, and 7.3

Sources
- Global Forest Watch Canada. Large Remaining Unfragmented Forest Areas (revised). (1 km resolution raster). 2001. (While newer versions of GFWC data are available, they include impacts of all disturbance, including non-permanent; this study utilized the 2001 data which defined forest blocks using 1:250,000 transportation data only. This allowed non-permanent disturbance to be treated as an indicator of forest quality, not a delimiter of forest blocks)
- DMTI Can-Map Streetfiles. 1:50,000 to 1:200,000. 2002.
- Power Lines in the "Lands for Life" area. OMNR. 1:600,000. 1997.
- Digital Chart of the World. Utility lines & corridors. 1:1,000,000.
- National Atlas Information Service. Railroads within Canada. 1:7,500,000.
- Quaternary Watersheds. OMNR. 1:20,000. 2002.
- Global Forest Watch Canada. Forest Tenures in Canada.
- Environment Canada & Agriculture Canada. Terrestrial Ecoregions of Canada.

Methodology
- The GFW grid was converted to a polygon theme to facilitate manipulation and areal calculations
- DMTI roads ("CARTO" classes 1 through 5; excludes trails, ferry routes, *etc.*), power lines, utilities and railroads themes were merged to create a Permanent Linear Infrastructure theme in the hopes of capturing infrastructure that may have been missed in the GFW analysis.
- The Permanent Linear Infrastructure theme was used to further dissect the GFW polygon theme
- All intact forest blocks that intersected the Study area (Terrestrial Ecoregions of Canada, Ecoregions 96 and 97) were then symbolized by their total area to produce Figure 7.1
- The forest blocks were intersected with the boundary of Iroquois Falls Forest, and each intersected block falling within Iroquois Falls

Forest and with an area >5,000 ha was assigned a unique identifier, creating Figure 7.2
- The forest blocks were further intersected with the Quaternary watershed boundaries falling within Iroquois Falls Forest, creating Figure 7.3

Figures 7.4 and Table 7.1

Sources
- Forest Blocks >5,000 ha Intersected by Iroquois Falls Forest and Quaternary Watershed Boundaries. Generated in Figures 7.2 and 7.3
- Roads in Iroquois Falls Forest. Abitibi Consolidated.
- Seismic lines for Canada. Compilation of seismic lines from Canada's NTS maps for Canadian Boreal Initiative (CBI).
- Quaternary Watersheds. OMNR. 1:20,000. 2002.
- Depletions in Iroquois Falls Forest. Abitibi Consolidated.
- Forest Resource Inventory for Iroquois Falls Forest. Abitibi Consolidated.

Methodology
- Within each Forest Block identified in Figure 7.1, the level of non-permanent, anthropogenic disturbance was derived by calculating the proportion of the block impacted by harvesting and forest roads
- All Abitibi roads categorized as non-gravelled tertiary or winter roads (Classes 4 and 5) and seismic lines were buffered 50m and this area was unioned with the area of depletions due to harvesting activity. Depletions due to fire were excluded.
- This layer of non-permanent disturbance was then intersected with the Large Forest Blocks and the level of disturbance was expressed as a proportion of the total block covered by the disturbance layer as per Table 7.1
- Late seral stands within Iroquois Falls Forest were identified by performing the following attribute query on the Forest Resource Inventory data to select qualified stands based on their age and Standard Forest Unit designation (Query based on Uhlig *et al.* 2001):

```
(("FU" = 'PR1') and ("AGE" >= 130)) or
(("FU" = 'PRW') and ("AGE" >= 130)) or
(("FU" = 'PW1') and ("AGE" >= 130)) or
(("FU" = 'BOG') and ("AGE" >= 150)) or
(("FU" = 'SB1') and ("AGE" >= 120)) or
(("FU" = 'SP1') and ("AGE" >= 100)) or
(("FU" = 'PJ1') and ("AGE" >= 110)) or
(("FU" = 'PJ2') and ("AGE" >= 100)) or
(("FU" = 'LC1') and ("AGE" >= 120)) or
(("FU" = 'SF1') and ("AGE" >= 90)) or
(("FU" = 'PO1') and ("AGE" >= 90)) or
(("FU" = 'BW1') and ("AGE" >= 90)) or
(("FU" = 'MW1') and ("AGE" >= 95)) or
(("FU" = 'MW2') and ("AGE" >= 100)) or
(("FU" = 'LH1') and ("AGE" >= 90)) or
(("FU" = 'TH1') and ("AGE" >= 145))
```

- The proportion of late seral forest within each forest block was derived by intersecting the late seral stands with the Forest Blocks identified in Figure 7.1 and summing their areas by forest block, as per Table 7.1
- All watershed-based analyses were performed on all data within Iroquois Falls Forest (*i.e.* data were not restricted to falling within the large forest blocks)
- The layer of non-permanent disturbance was intersected with the Quaternary Watershed boundaries and the level of disturbance was expressed as a proportion of the watershed covered by the disturbance layer as per Table 7.1
- The level of permanent disturbance was calculated as the kilometres of Permanent Linear Infrastructure (as defined in Figure 7.1) per square kilometre for each watershed as per Table 7.1
- The proportion of late seral forest within each watershed was derived by intersecting the late seral stands with the Quaternary Watershed boundaries and summing their areas, as per Table 7.1

RARE, UNIQUE OR DIVERSE ECOSYSTEMS

HIGH CONSERVATION VALUE 3, QUESTIONS 8 & 11

Does the forest contain naturally rare ecosystem types?
Are there nationally/regionally significant diverse or unique forest ecosystems?

BACKGROUND

The HCVF framework contains significant overlap between Questions 8 and 11, dealing respectively with rare ecosystems, and ecosystems that are unique or diverse.

The major point of differentiation between these questions is the scale at which the investigations are aimed, and the subsequent data sources that are applicable. Question 8 is intended to deal more with international and national level rarity and significance. Investigations will tend to rely on list-based resources in the same way that Question 1 is focused on listed Species at Risk (*e.g.* consultation of G-Ranks, *etc*.). Question 11 looks more toward regional level significance and unique or outstanding occurrences of ecosystems. For this question, gathering information from local experts and authorities is a more valuable line of enquiry.

The issues associated with identifying naturally rare ecosystem types are also germane to identifying and locating especially diverse or unique ecosystem types. For this reason, we have combined the discussion of these Questions into a single document.

All ecosystem types result from interrelationships between climate, physiographic features, soil, micro and macro organisms, and vegetation. Naturally rare ecosystems often occur along more narrow moisture, nutrient and microclimate gradients than do more common ecosystem types.

Rare ecosystem types may also occur as remnants following some type of major disturbance. Remnant populations and systems resist extinction due to a pronounced ability to persist without completing a whole life-cycle (*e.g.*, long-lived vegetative life cycle stages). These ecosystems provide resilience to disturbance by enhancing post-disturbance colonization, providing persistent habitat assemblages of animals and micro-organisms, and by reducing variation in nutrient cycling (Eriksson 2000). Therefore, rare ecosystem types may be important elements of a protected areas network (FSC Criterion 6.4) in terms of both ecosystem representation and resilience.

The HCVF framework also recognizes that unique and diverse forest ecosystems are valuable due to their potential vulnerability, species diversity and the significant ecological processes they may include

We have identified three principal issues related to how these questions have been addressed in HCVF assessments to date:

1. Lack of data: Identifying rare ecosystem types within FMAs has proven challenging in many instances due to a lack of readily available data. Classifications of rare and sensitive ecosystems exist for some regions and not for others. Further, the criteria, data and scale used to assess ecosystem types are often not consistent across political boundaries. Here we suggest several approaches to identifying rare ecosystem types by developing proxies using multiple data sources at varied scales.

2. Scale: The definition of 'rare' is scale-dependent; an ecosystem type may be common globally but rare locally, or vise versa. Therefore, the occurrence of ecosystem types should be assessed across local, regional and global landscape scales. Data ranging from coarse to fine filter should be examined.

3. Lack of spatial analysis: To date, maps of rare ecosystem types have commonly been omitted from HCVF assessments. Mapping information about rare ecosystem types at multiple scales - those located in, adjacent to and within the region of the FMA - may assist in determining thresholds of HCVF status. Further, providing maps of all rare ecosystem types, regardless of eventual HCV designation, provides important information for forest management and monitoring, and will help when assessing areas of HCV overlap (Question 19).

DATA SOURCES

The HCVF Framework for Canada lists the following possible data sources:

- Conservation Data Centre G1-G3 community types
- WWF Terrestrial Ecoregions of North America
- Conservation International
- National vegetation surveys and maps
- Local Research institutions
- Authorities on Biodiversity (*e.g.*, NatureServe, Infonatura)

Conservation International (CI) data are not broadly applicable in Canada; CI's focus is on global biodiversity 'hotspots' which are generally clustered in tropical and southern temperate regions. To qualify as a CI hotspot, a region must have lost at least 70 percent of its original vegetation due to the impact of human activities and hold at least 1,500 endemic plant species.

WWF's Terrestrial Ecoregions of North America (Ricketts *et al.* 1999) addresses conservation elements on a broad, continental scale. Similarly, national vegetation surveys and maps are also drawn on a

HCV3 Q8/11 – RARE, UNIQUE OR DIVERSE ECOSYSTEMS

Figure 8.1 Ranked areal extent of Enduring Features within the study area, with the rarest quartile highlighted.

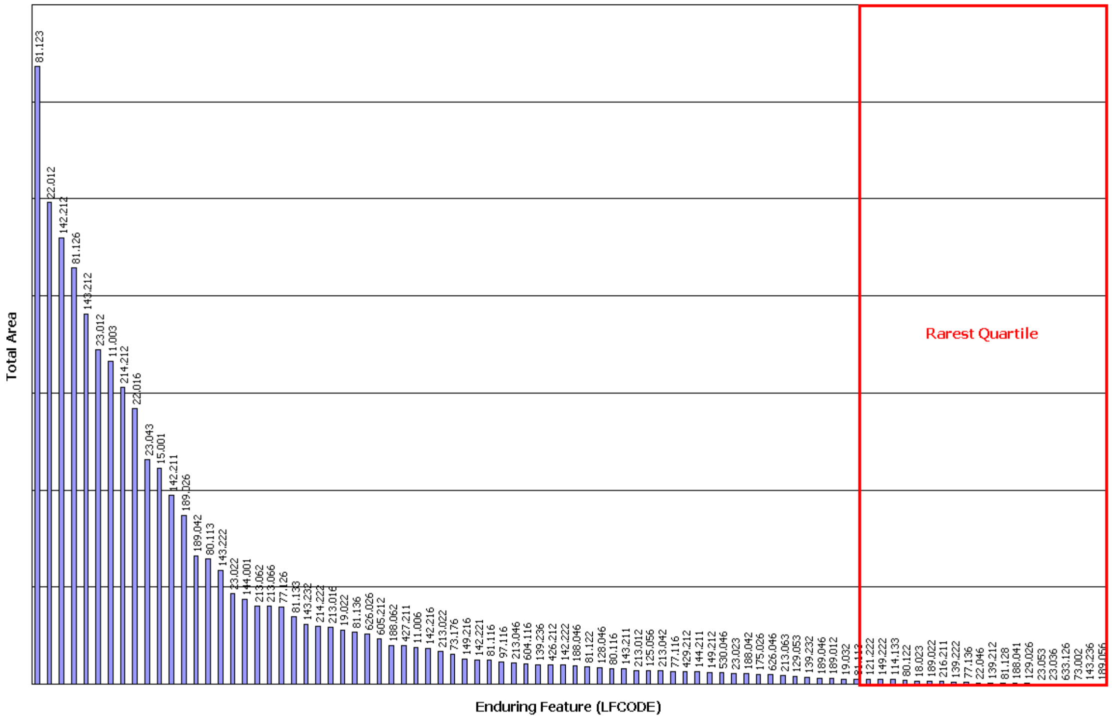
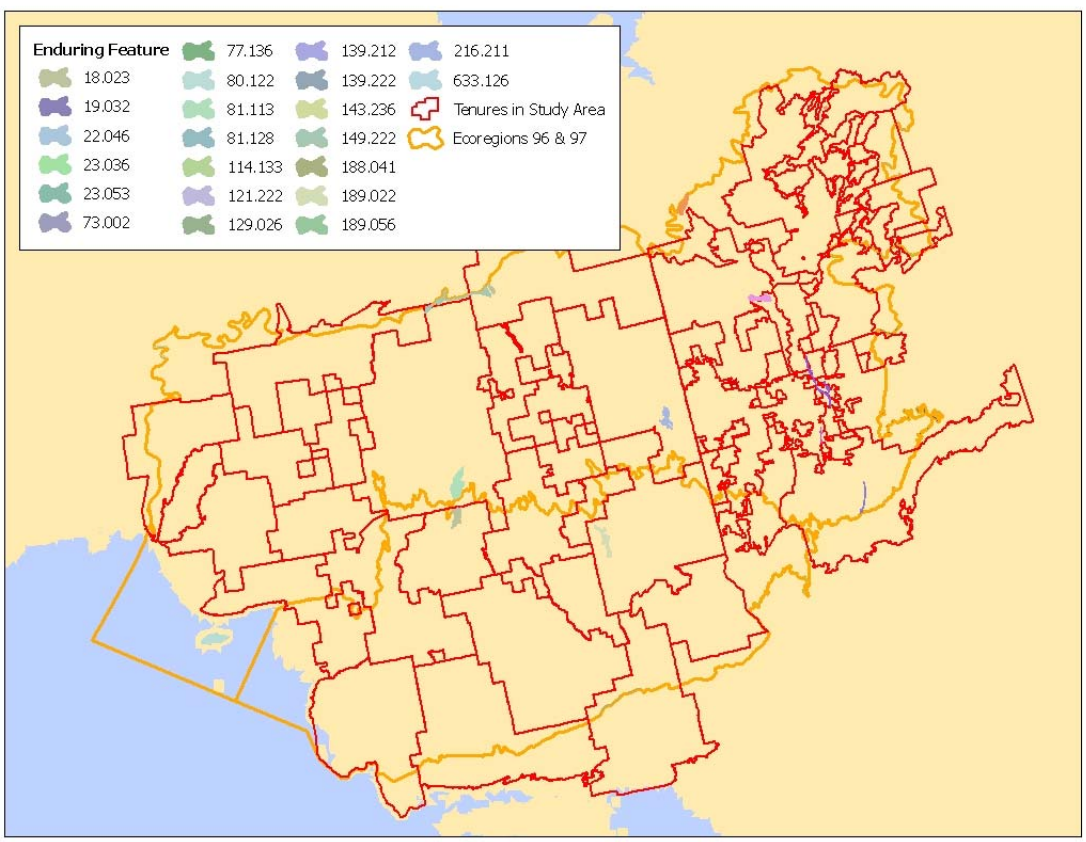


Figure 8.2 Distribution of the rarest quartile as identified in Figure 8.1) of Enduring Features within the study area.



continental scale. We suggest using these documents as part of a first step to flag obvious rare ecosystems.

Authorities on biodiversity, such as NatureServe and Infonatura, coordinate and catalogue regional information from the Conservation Data Centers (CDC), Natural Heritage Information Centers (NHIC) and Natural Heritage Data Centers (NHDC) across Canada. These are all good sources of regional or medium filter information. Fine filter information is most often available through local research institutions and thorough regional studies.

Additional data sources that would be relevant to addressing the issue of rare ecosystems include:

- Provincial ecosite or ecosystem inventories
  - Ontario MNR NEFEC Inventory
  - BC Sensitive Ecosystem Inventories
- Provincial CDC, NHIC, NHDC
- Regional sources:
  - Alberta: Timoney 2003, Archibald *et al.* 1996, Beckingham and Archibald 1996, Beckingham *et al.* 1996, Plant community tracking list (http://www.cd.gov.ab.ca/preserving/parks/anhic/plantcomm.asp)
  - Saskatchewan: Beckingham *et al.* 1999
  - Ontario: OMNR Landform Vegetation dataset, NOEGTS dataset (1:100,000 scale; intended for engineering use, but broad descriptive database may be useful element of a predictive model)
  - Manitoba: Zoladeski *et al.* 1995
- WWF Enduring Features dataset (1:1,000,000 scale; provides information on physiographic features, geology and soils)
- Global Land Cover 2000 or USGS Global Seasonal Land Cover data set (very coarse scale remotely-sensed land cover datasets; USGS dataset contains some erroneous species compositions, such as western Hemlock in Northeastern Ontario, but the data is still of utility to assess the distribution of community types across large geographic areas).

ADDITIONAL GUIDANCE

Are unique physiographic features or rare geologic formations or soils present within the FMA or region?

In areas where a classification of rare ecosystem types is not available or not available at a fine enough scale, identifying what factors contribute to making ecosystem types rare may help with identifying their occurrence on the ground. Species are sometimes rare due to similarly rare ecosystem parameters (Rabinowitz 1981; Rabinowitz *et al.* 1986) therefore identifying occurrences of rare species and/or rare species habitat (HCV 1), if available, may point to rare ecosystems.

Figure 8.3 Distribution of aeolian deposits within the entire study area based on the Northern Ontario Engineering Geology Terrain Studies dataset.

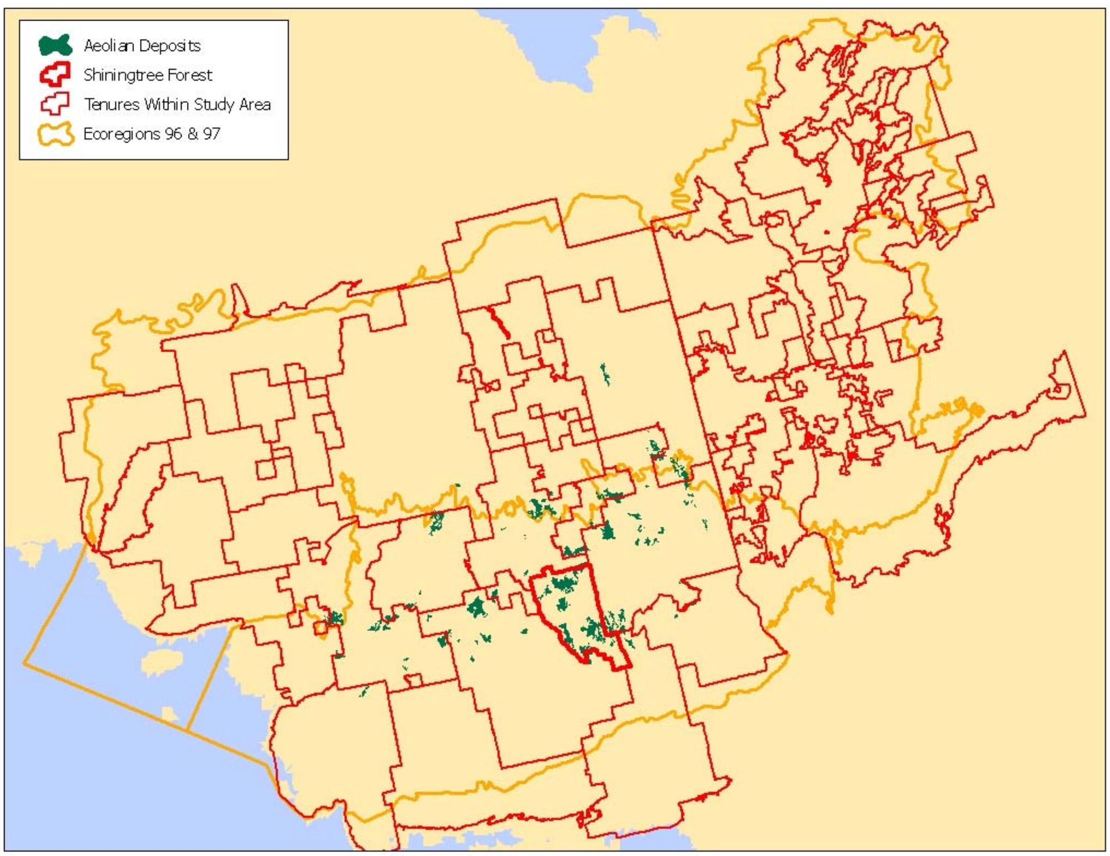


Figure 8.4 Decision matrix illustratingthe proportion of rare ecosystems to be captured in HCVF zones, based on their regional and local levels of rarity.

		REGIONAL	
		Rare	*Common*
LOCAL	*Rare*	**100 %**	***n* %**
	Common	***n* %**	**N/A**

Narrow ecosystem parameters, such as small geological formations (*e.g.*, isolated limestone outcrops), unique physiographic features (*e.g.*, sand dunes), or rare soil types (*e.g.*, serpentine soils) often host rare ecosystem types. Therefore, identifying any such parameters may help in locating rare ecosystem types.

One analytical approach to addressing this question is to examine the frequency distributions of various mappable ecological parameters and focus investigations on the "tail", or rarest quartile of the distribution. A related approach is to model or predict ecosites through mapping biotic and abiotic inventory data (for example, by ecodistrict at 1:20,000 to 1:100,000 scales). This mapping can then be used as a base to conduct a similar analysis of rarity.

Figure 8.1 illustrates the ranked abundance of Enduring Features (physiographic features based on 1:1,000,000 scale soils data) in the study area. Mapping the rarest quartile of the distribution creates a coarse filter pass of sites potentially hosting rare ecosystems (Figure 8.2). The rarest quartile was identified in this example simply to select the less common potential community types. Focusing in on these rare physiographic types, finer scale data can then be assessed to determine their distribution more precisely and investigate the potential community types they support.

For example, aeolian deposits fall within the rarest quartile of the Enduring Feature frequency distribution, and are represented by a single occurrence in the Pineland Forest (Figure 8.2). Aeolian deposits have the potential to support rare vegetative communities (the Natural Heritage Information Centre in Ontario tracks several dune communities), and can be highly sensitive to disturbance. Further investigation with a finer scale dataset (NOEGTS, 1:100,000 scale landform and geology data) reveals a somewhat wider, significantly clustered distribution of landforms that are dominated by aeolian deposits (Figure 8.3).

This patchy distribution results in these deposits being locally common in some tenures, but locally rare or absent from others. It is precisely this pattern that a multi-scaled line of investigation can detect. From a tenure-level analysis alone (Figure 8.5), these landforms (and their potentially supported ecosystems) appear to be widespread. Scaling the analysis up to encompass the entire study area, we note the concentration of these deposits in and around the tenure, and the general paucity of this landform in the wider region (Figure 8.3).

Given the patchy distribution throughout the region, it is recommended that all isolated occurrences of aeolian deposits be considered as possible HCVFs. In larger clusters of occurrences however (*e.g.* the Shining Tree forest illustrated in Figure 8.5), some proportion of the aeolian deposits should be identified as possible HCVFs. The subsequent investigation should attempt to determine what proportion and which occurrences.

These questions can be addressed in a general way by a comparison of the distributions at the regional and local scales. This decision matrix is illustrated in Figure 8.4. If the HCV in question is rare at both the regional and local scales, all occurrences of the value should be captured in HCVF zones. If the value is common at both the regional and local scales, the value would not qualify as a HCV and there is no requirement for any of it to be represented in HCVF zones.

The remaining two options, regionally rare but locally common (*e.g.* the aeolian deposit example above) and locally rare but regionally common, both need capture only a proportion (*n*) of the occurrences in HCVF zones. That being said, the functional requirements of many species and communities demand larger areas of clustered habitat. A greater proportion or more

Figure 8.5 Distribution of aeolian deposits within Shiningtree Forest based on the Northern Ontario Engineering Geology Terrain Studies dataset.

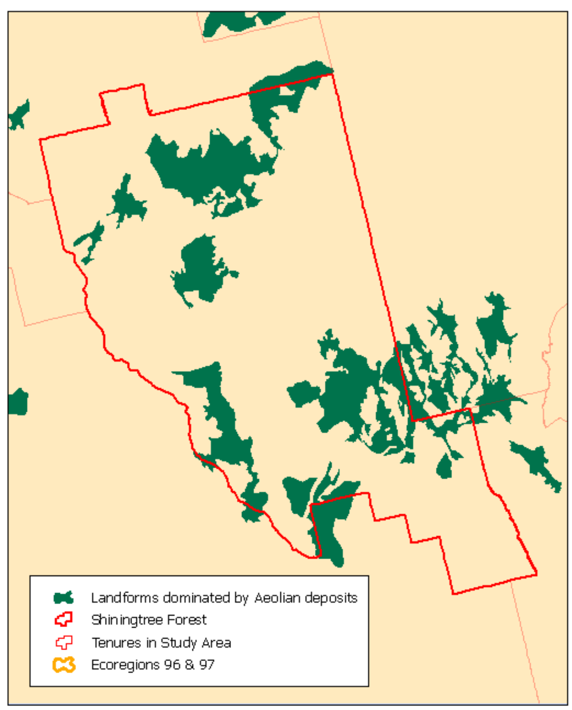
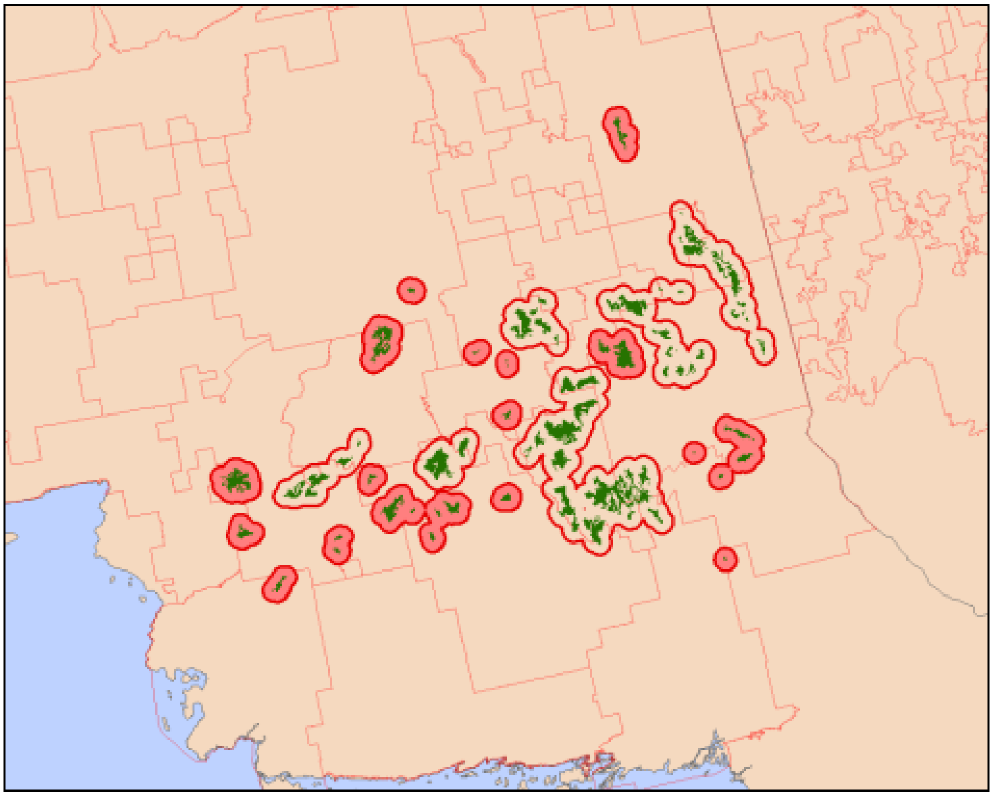


Figure 8.6 Distribution of aeolian deposits shown in green. Clusters of deposits are outlined in red; clusters which constitute "locally rare" occurrences are outlined and shaded red. Individual occurrences were amalgamated into clusters if their nearest neighbouring occurence was less than the average nearest neighbour distance for the entire distribution.



clustered selection of these community types might be identified than others. Furthermore, additional conservation attributes will likely need to be associated with locally rare, but regionally common habitat types to be verified as HCVs.

The delineation of when a value is "locally rare" or "locally common" can be subjective. Figure 8.6 illustrates a potential analysis aimed at making this decision somewhat more objective. In this figure, clusters of deposits were identified by grouping all occurrences that were separated by less than the average nearest-neighbour distance of the entire distribution. The size of these clusters was then assessed against the total size of the distribution. If a cluster was found to contain less than 5% of the area of the total distribution, then it was categorized as locally rare and, as per Figure 8.4, would be targeted for 100% representation in an HCVF zone given that this is a regionally rare HCV. Clusters containing greater than 5% of the area of the total distribution were categorized as locally common, and would be targeted for proportional representation in HCVF zones.

The actual proportion that should be designated as HCVF (denoted as *n* in Figure 8.4) and which individual occurrences should be designated would be determined through consideration of the overall rarity of the value in the landscape, the geographic distribution of the patches, and indicators of patch quality. The spatial clustering of values highlighted by Question 19 can also be helpful in determining which occurrences should be classified as HCV.

Are there ecosystems that have been classified as rare by a relevant regional or provincial organization?

The Conservation Data Centers, Natural Heritage Information Centers and Natural Heritage Data Centers throughout Canada work primarily within provincial boundaries, and in some cases may be the best source of information on rare ecosystem types. Where possible, these communities should be mapped, either directly where relevant data can be brought to bear, or via proxy data.

For example, the Natural Heritage Information Centre in Ontario lists "Dry Red Pine-White Pine Coniferous Forest Type" as S4, G3/G4 can be mapped directly from Forest Resource Inventory data by querying for Pw/Pr Standard Forest Units.

Are rare species or community associations present within the FMA or region?

HCV3 Q8/11 – Rare, Unique or Diverse Ecosystems

Clusters of rare species or community types can be indicators of rare, unique or diverse ecosystems. These systems will likely also be flagged through an overlapping values analysis of the type required for Question 19.

Related HCVF Questions and areas of possible overlap

- Question 1 – rare species may occur within rare ecosystem types.
- Question 5 – concentrations of species at the range edge could signify the presence of regionally rare ecosystem types.
- Question 6 – representation in conservation /protected areas network

Summary of Recommendations

- Identify rare ecosystem types by developing proxies using multiple data sources (*e.g.*, physiographic features, soils, rare geologic formations) at varied scales.
- Spatially assess occurrences of rare ecosystem,
- species and community types across scales.

Literature Cited

Archibald, J.H., G.D. Klappstein, and I.G.W. Corns. 1996. Field guide to ecosites of southwestern Alberta. Canadian Forest Service, Northern Forestry Centre Special Report 8. 492 pages.

Beckingham, J., V. Furoransky and I. Corns. 1999. Ecological classification of Saskatchewan's mid-boreal ecoregions using resource maps and serial photographs. Northern Forestry Centre Special Report 14. UBC Press.

Beckingham, J.D., and J.H. Archibald. 1996. Field guide to ecosites of northern Alberta. Canadian Forest Service, Northern Forestry Centre Special Report 5. 528 pages.

Beckingham, J.D., I.G.W. Corns, and J.H. Archibald. 1996. Field guide to ecosites of west-central Alberta. Canadian Forest Service, Northern Forestry Centre Special Report 9. 540 pages.

Eriksson, O. 2000. Functional Roles of Remnant Plant Populations in Communities and Ecosystems. Global Ecology and Biogeography. Vol. 9, No. 6. pp. 443-449.

Rabinowitz, D. 1981. Seven forms of rarity. In: Biological Aspects of Rare Plant Conservation [Synge, H. (ed.)]. John Wiley and Sons, Chichester, United Kingdom, pp. 205-217.

Rabinowitz, D., S. Cairns, and T. Dillon. 1986. Seven forms of rarity and their frequency in the flora of the British Isles. In: Conservation Biology: The Science of Scarcity and Diversity [Soulé, M. (ed.)]. Sinauer, Sunderland, MA, USA, pp. 182-204.

Ricketts, T., E. Dinerstein, D. Olson, C. Loucks, W. Eichbaum, D. Dellasala, K. Kavanagh, P. Hedao, P. Hurley, K. Carney, R. Abell and S. Walters. 1999. Terrestrial ecoregions of North America: a conservation assessment. Island Press.

Timoney, K. 2003. An environmental assessment of high conservation value forests in the Alberta portion of the mid-continental Canadian boreal forest ecoregion.

Zoladeski, C.A., G.M. Wickware, R.J. Delorme, R.A. Sims, and I.G.W. Corns. 1995. Forest ecosystem classification for Manitoba: field guide. Canadian Forest Service, Northern Forestry Centre Special Report 2. 205 pages.

Methodology

Figure 8.1 and Table 8.1

Sources

- World Wildlife Fund Canada. Enduring Features for Ontario and Quebec. 1:1,000,000.
- Global Forest Watch Canada. Forest Tenures in Canada.
- Environment Canada & Agriculture Canada. Terrestrial Ecoregions of Canada.

Methodology

- The Enduring Features datasets for Ontario and Quebec were merged and clipped to the study area (Terrestrial Ecoregions of Canada 96 and 97)
- The enduring features were grouped by landform code (LFCODE) and were arranged by ranked total area, creating Table 8.1
- The landforms falling in the lowest quartile (22 of 88 unique LFCODEs) with respect to their total area were selected and mapped to created Figure 8.1

Figures 8.2, 8.3

Sources

- Ontario Geological Survey. Digital Northern Ontario Engineering Geology Terrain Studies (NOEGTS). 1:100,000.
- World Wildlife Fund Canada. Enduring Features for Quebec. 1:1,000,000.
- GeoGratis. Surficial Geology of Canada. 1:2,000,000.
- Global Forest Watch Canada. Forest Tenures in Canada.
- Environment Canada & Agriculture Canada. Terrestrial Ecoregions of Canada.

Methodology

- The NOEGTS dataset was clipped to the study area
- All aeolian features were extracted by performing an attribute query to select all landforms coded as "ED"
- As this dataset covers the Ontario portion of the Study Area, the Surficial Geology of Canada and the Enduring Features datasets were used to fill in the Quebec portion. Neither dataset indicated any aeolian features

- Aeolian features were depicted from both a tenure-based perspective, focusing on Shiningtree Forest (Figure 8.3), and a regional perspective, showing the entire Study Area (Figure 8.2)

ECOSYSTEMS IN DECLINE

HIGH CONSERVATION VALUE 3, QUESTION 9

Are there ecosystem types within the forest or ecoregion that have significantly declined?

BACKGROUND

An ecosystem type may decline within a forest or ecoregion due to many different factors. For example, the removal of targeted species may create anthropogenically rare forest ecosystem types (*e.g.*, late seral red and white pine in eastern Canada). Altered disturbance regimes (*e.g.*, through fire suppression, introduced forest pests or pathogens, altered hydrology) may cause declines in certain ecosystem types, especially those that are highly vulnerable to or dependent on a particular disturbance (*e.g.*, fire dependent systems, woodland encroachment in flood plains resulting from water control structures). In some cases removal or range expansion of a keystone species causes changes in the structure or function of an ecosystem (*e.g.*, beaver). Researchers predict that climate change will cause declines in some forest communities and change the structure of others (Chapin *et al* 2004). Declines in particular ecosystem types have implications for habitat, and are significant because the viability of meta populations may become threatened as an ecosystem type declines regionally.

We have identified three principal issues related to how this question has been addressed in HCVF assessments to date:

1. The definition of decline: Ecosystem decline is principally interpreted as vegetation change. We suggest that decline in faunal elements and ecosystem function (*e.g.*, hydrologic cycle) also constitutes change under this indicator.

2. Baselines: By definition, measuring decline requires a known and appropriate baseline. To date, many HCVF assessments in areas where forests have been harvested for much of the last century have measured decline relative to FRI or other data dating back only several decades. We recommend identifying and documenting decline relative to pre-industrial conditions.

3. Scale: Many assessments have only addressed decline on a regional level. We suggest that finer scale analyses are necessary (*e.g.*, have once common local ecosystem types become scarce?).

DATA SOURCES

The HCVF Framework for Canada lists the following possible data sources:

- Relevant government authorities;
- WWF Terrestrial Ecoregions of North America (Ricketts *et al*. 1999);
- Suitable forest or vegetation inventories;
- Potential vegetation mapping;
- Regional and local experts;
- Conservation Data Centre S1-S3 community types.

Additional data sources might include:

- Provincial ecosite or ecosystem inventories, such as:
  - Ontario MNR NEFEC Inventory
  - BC Sensitive Ecosystem Inventories
- Photography from early or pre-industrial era
- Extrapolation/reconstruction from reference areas (*e.g.*, regional or national parks, refuges)
- Regional sources:
  - Alberta: Timoney 2003, Archibald *et al*. 1996, Beckingham and Archibald 1996, Beckingham *et al*. 1996
  - Saskatchewan: Beckingham *et al*. 1999
  - Ontario: OMNR Landform Vegetation dataset, NOEGTS dataset (1:100,000 scale; intended for engineering use, but broad descriptive database may be useful element of a predictive model)
  - Manitoba: Zoladeski *et al*. 1995

INTERPRETING GLOBAL, NATIONAL AND REGIONAL SIGNIFICANCE

As with naturally rare ecosystem types dependent on narrow ecosystem parameters, the definition of decline is scale dependent. We recommend that HCVF assessments include spatial analysis of the current and pre-industrial ecosystem types located in, adjacent to and within the region of the FMA. If pre-industrial cover data is not readily available, we suggest it should be re-constructed or modeled.

INTERPRETING THE PRECAUTIONARY PRINCIPLE

In the absence of definitive information regarding ecosystems that may be declining, the precautionary principle would lead us to target ecosystem types that are threatened by anthropogenic activity on the landscape. For example, wetlands are often targeted by agriculture for draining and greenbelt mineral deposits are often the focus of mining activity.

Conventional forestry practices target old forest stands first. Under traditional sustained yield management practices there is no requirement to maintain forests older than the optimal rotation age. Therefore, we suggest it is appropriate under the precautionary principle to designate old, merchantable forest types as HCVF.

HCV3 Q9 – ECOSYSTEMS IN DECLINE

ADDITIONAL GUIDANCE

Consult information on species declines and major anthropogenic disturbances

The loss of a significant species within an ecosystem (*e.g.*, caribou, beaver) can cause changes in system function and structure. A broad spectrum of human activities can have cumulative impacts on an ecosystem that may lead to decline; examining the history and impact of various activities will help in choosing an appropriate baseline for assessing decline.

In this document, we have noted that the presence of eastern white pine and red pine at the northern part of their range has been identified as HCVFs under Question 5 (range edge and outliers). A supplementary rationale to identify this community type as a range edge HCV is because of declines in the main part of their range resulting from historical highgrading of large, old trees. Hence, in mixedwood forests of central Ontario, late seral red and white pine have been identified as HCVFs. We would suggest that forest stands with the potential to support late seral red and white pine should also be identified as HCVFs in addition to existing remaining stands.

Spatial analysis

As a result of on ongoing development of HCVF methodologies, it is still common for HCVF reports not to contain maps for every assessed conservation attribute. We recommend mapping information about ecosystem types, including forest communities and proportion and distribution of seral stages. Examining the distribution and extent of an ecosystem type is key to measuring decline and may assist in determining thresholds of HCVF status. Further, providing maps of all diminished ecosystem types, regardless of eventual HCV designation, provides important information for forest management and monitoring, and will help when assessing areas of potential HCV overlap (Question 19).

Choose an appropriate baseline

Factors to consider in choosing an appropriate baseline include:

- Harvest history
- History and effects of other management activities
- History of other human activities in the region

We recommend the following questions as additional guidance

- Have focal, keystone or other species declined in the region or locally (*e.g.*, caribou or beaver)?
- Has some human activity significantly altered the landscape (*e.g.*, hydroelectric or oil and gas development)? How?
- When was the forest first harvested and when were other management prescriptions (*e.g.*, fire suppression, reforestation) enacted? What impact do these activities have on local ecosystems?

Related HCVF Questions and areas of possible overlap

- Question 8 – Rare ecosystem types
- Question 1 – Species or habitats at risk
- Question 10 – Forest fragments

SUMMARY OF RECOMMENDATIONS

- An evaluation of ecosystems in decline should include both floral and faunal elements of ecosystems.
- Pre-industrial conditions constitute an appropriate baseline from which to measure decline; if pre-industrial cover data is not available, we suggest it should be re-constructed or modeled.

LITERATURE CITED

Archibald, J.H., G.D. Klappstein, and I.G.W. Corns. 1996. Field guide to ecosites of southwestern Alberta. Canadian Forest Service, Northern Forestry Centre Special Report 8. 492 pages.

Beckingham, J., V. Furoransky and I. Corns. 1999. Ecological classification of Saskatchewan's mid-boreal ecoregions using resource maps and serial photographs. Northern Forestry Centre Special Report 14. UBC Press.

Beckingham, J.D., and J.H. Archibald. 1996. Field guide to ecosites of northern Alberta. Canadian Forest Service, Northern Forestry Centre Special Report 5. 528 pages.

Beckingham, J.D., I.G.W. Corns, and J.H. Archibald. 1996. Field guide to ecosites of west-central Alberta. Canadian Forest Service, Northern Forestry Centre Special Report 9. 540 pages.

Chapin, S., T. Callaghan, Y Bergeron, M. Fukuda, J. Johnstone, G. Juday and S. Zimov. 2004. Global change and the boreal forest: Thresholds, shifting states or gradual change? Ambio 33(6): 361-365

Ricketts, T., E. Dinerstein, D. Olson, C. Loucks, W. Eichbaum, D. Dellasala, K. Kavanagh, P. Hedao, P. Hurley, K. Carney, R. Abell and S. Walters. 1999. Terrestrial ecoregions of North America: a conservation assessment. Island Press.

Timoney, K. 2003. An environmental assessment of high conservation value forests in the Alberta portion of the mid-continental Canadian boreal forest ecoregion.

Zoladeski, C.A., G.M. Wickware, R.J. Delorme, R.A. Sims, and I.G.W. Corns. 1995. Forest ecosystem classification for Manitoba: field guide. Canadian Forest Service, Northern Forestry Centre Special Report 2. 205 pages.

Sources of Drinking Water

High Conservation Value 4, Question 12

Does the forest provide a significant source of drinking water?

Background

The HCVF Framework for Canada recognizes that the potential impact to human communities of loss or damage to sole drinking water supplies is "so significant as to be 'catastrophic' leading to significant loss of productivity, or sickness and death".

Forest areas play an important role in maintaining ecosystem services, including water quality and quantity (MEA 2005). Water quality and quantity are important for sustaining aquatic life and are influenced by the properties of the watershed, including geology, topography, soils, vegetation, and the presence of wetlands. Wetlands provide flood mediation, sediment trapping, nutrient trapping and release, and can play critical roles in both groundwater recharge and discharge. Riparian areas play an important role in regulating water temperature and sedimentation, and in accumulating and releasing nutrients from and to the surrounding forestlands. Water quality and quantity have been used as federal environmental indicators (NRTEE 2003; CCFM 1997); water and the hydrological cycle are clearly important ecological features of boreal forests.

We have identified four principal issues related to how this question has been addressed in HCVF assessments to date:

1. Understanding regional and local hydrology: Determining what water sources are potentially at risk to direct, indirect and/or cumulative impacts from forest management and other activities first requires an analysis of the local and regional hydrology. A hydrological assessment should be the first step toward fully addressing Question 12.

2. Scale of analysis: As with most HCV analyses, evaluations of forests providing a significant source of drinking water should be conducted at multiple scales (*e.g.*, primary, secondary, tertiary, quaternary watersheds).

3. Spatial analysis and maps: A spatial representation of watersheds (including wetlands and drinking water catchment areas, where possible) is important for both understanding and conveying information on hydrology within a forest area.

4. Address water quantity and water quality: Analyses must consider both water quantity and water quality issues associated with forest cover and management.

Data Sources

The HCVF Framework for Canada recommends that forest practitioners consult the relevant authorities (resource management studies, relevant economic development studies, traditional occupancy studies, regional land use plans, *etc.*) to determine if forest management practices could cause serious cumulative or catastrophic impacts on these basic services.

Additional data sources relevant to addressing the issue of drinking water protection include:

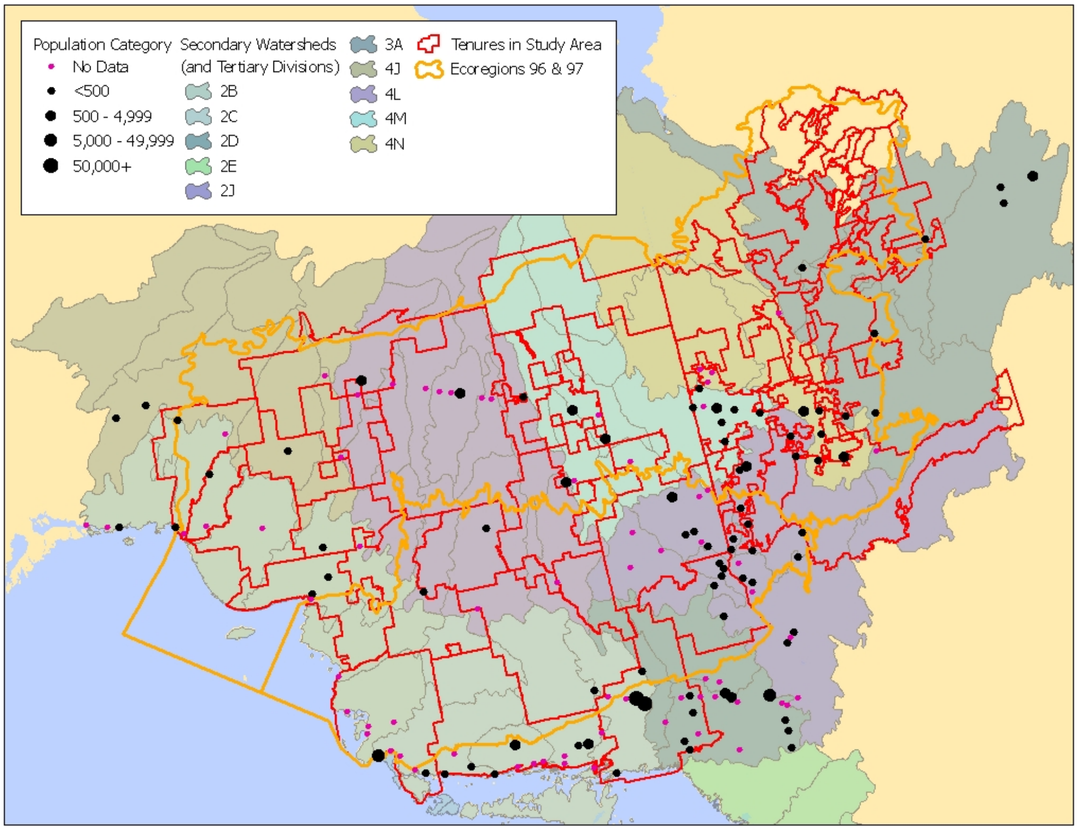
- Headwater watersheds from 2nd order streams (Available in Ontario from the OMNR's Water Resource Information Project)
- Canadian Federation of Municipalities – information on wells and other water sources
- Local terrain mapping and base maps showing topography
- Regional watershed plans
- Provincial watershed maps
- Provincially Significant Wetlands (Ontario)
- Ontario Ministry of Environment water well and groundwater information (http://www.ene.gov.on.ca/envision/water.htm)
- Alberta Environment groundwater information (http://www3.gov.ab.ca/env/water/groundwater/index.html)
- BC Ministry of Water, Land and Air Protection

Table 12.1 Population centres by watershed in Gordon Consens Forest.

3' Watershed	4' Watershed	Total Area of 4' Watershed (ha)	Proportion of 4' Watershed in Gorden Cosens	Community	Population	Total Population in 4' Watershed
4LD	4LD-01	198,389	98.0%	Fauquier	678	678
4LF	4LF-01	264,997	100.0%	Val Rita	511	9,749
				Kapuskasing	9,238	
	4LF-02	34,857	100.0%	Moonbeam	1,201	1,201
	4LF-03	106,712	100.0%	Harty	511	511
4LJ	4LJ-01	174,336	81.5%	Mattice	900	900
4LL	4LL-01	208,634	84.4%	Opasatika	325	325

HCV3 Q12 – Sources of Drinking Water

Figure 12.1 Centres of population and secondary and tertiary watershed boundaries.



- water well, aquifer and groundwater information (http://wlapwww.gov.bc.ca/wat/gws/)
- Manitoba water information maps (http://www.gov.mb.ca/waterstewardship/water_info/maps/index.html)
- Saskatchewan Water Authority information on groundwater assessments, mapping and wells (http://www.swa.sk.ca/WaterManagement/Groundwater.asp)
- Consultation with local communities and community leaders.

Interpreting Regional and Local Significance

Analyses of community drinking water supplies should include an examination of not only sole drinking water supplies, but of all regionally and locally significant drinking water sources. Determinations of regional and local significance should be made in consultation with communities. This approach is also consistent with the precautionary principal.

Interpreting the Precautionary Principle

Analyses of drinking water supplies should consider potential impacts to both water quality and water quantity and should consider cumulative impacts of forest management, other land uses and natural disturbances. For example, post fire flooding and related impacts can result in sediment loading into rivers, streams and wetlands. The potential cumulative impact of a stand-replacing wildfire or a 100 year flood and new forest roads should be considered.

In some areas toxic burdens (*e.g.*, mercury loads) in water are an issue, with toxics re-entering the water column if disturbed. We recommend water testing if historical land use provides reason to suspect toxins may be present. If toxins are present in FMA streams higher precaution per amount of load would be required. In all situations, baselines for water quality and quantity should be established and recorded.

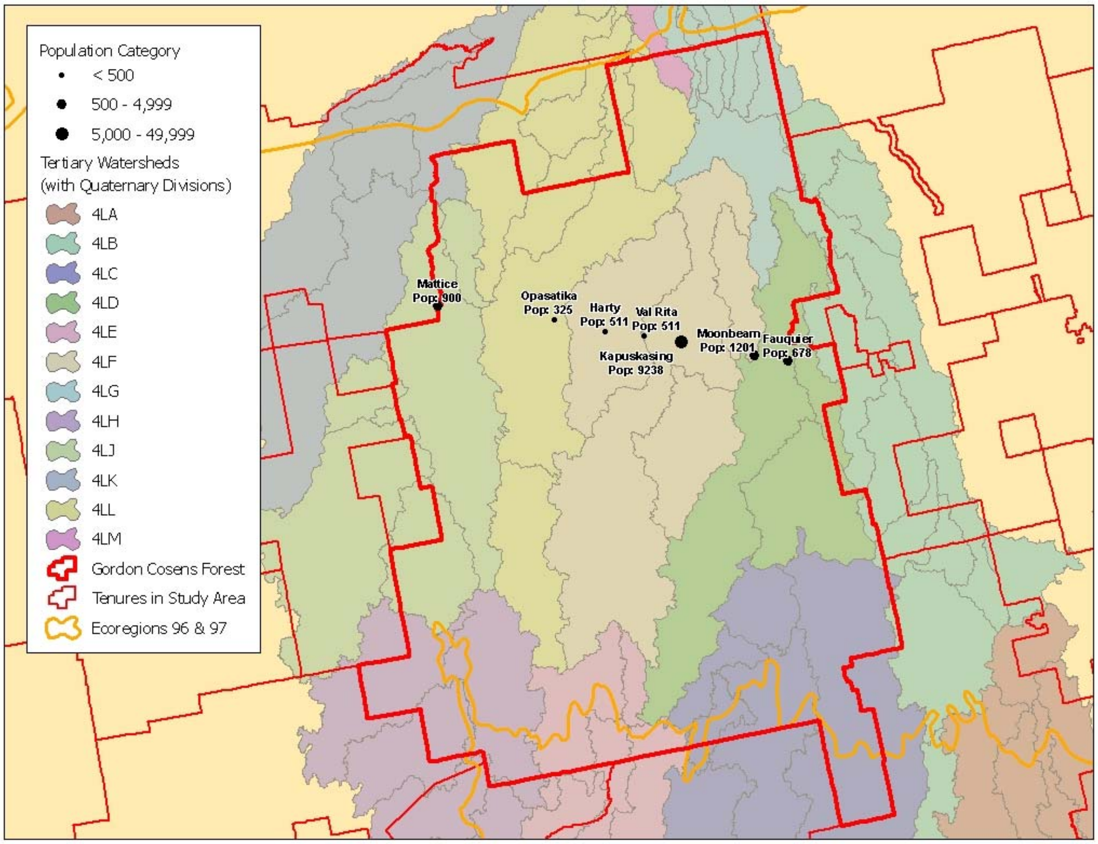
In the absence of completed watershed and/or hydrological flow assessments, it will be difficult to isolate those forest areas or catchments that are of critical importance to maintaining drinking water quality and supplies. Perhaps the most celebrated example is the Catskill/Delaware Watershed (http://www.nyc.gov/html/dep/watershed/home.html), which supplies 90% of the daily needs of the New York City Water Supply for 9 million residents.

Additional Guidance

Identifying water recharge areas in the absence of specific data

HCV3 Q12 – SOURCES OF DRINKING WATER

Figure 12.2 Centres of population within Gordon Cosens Forest and tertiary and quaternary watershed boundaries.



If reservoir or well locations are not available, one approach is to look at relationships between population centres within the tenure, and local and regional drainages.

Figure 12.1 provides an example of this regional perspective, illustrating all secondary and tertiary watersheds intersecting the study area, and the locations of the tenures and population centres. Figure 12.2 scales this down to the level of a single tenure, Gordon Cosens Forest, and shows the tertiary and quaternary watersheds overlaid with centres of population. Table 12.1 provides a summary of the watersheds with communities and the total populations per watershed.

We recommend that direct measurements of hydrology (water level, trends, timing and in-stream flow) be used as indicators of water quantity. We further suggest that a set of water quality indicators be chosen and monitored for HCVFs identified under this category. These indicators may include turbidity, concentration of dissolved organic carbon or nutrients. Suter *et al* (1995) proposed a threshold of 20% reduction in measured physical or chemical parameters as a significance standard for ecological risk assessment. We propose this 20% threshold be applied to HCVFs under Question 12.

We recommend the following question as additional guidance

- If groundwater wells are the source of drinking water for a community, does the groundwater come from one aquifer?

Related HCVF Questions and areas of possible overlap

- Question 13 – Flood control/drought alleviation
- Question 14 – Erosion control
- Question 16 – Impacts to fisheries

SUMMARY OF RECOMMENDATIONS

- Understand regional and local hydrology
- Analyses of drinking water supplies should be conducted at multiple scales (*e.g.*, primary, secondary, tertiary, quaternary watersheds).
- Spatial analysis and maps are important
- Identify all regionally and locally significant drinking water sources as part of HCVF analysis
- Consider cumulative impacts of forest management, other land uses and natural disturbances

HCV3 Q12 – Sources of Drinking Water

Literature Cited

CCFM (Canadian Council of Forest Ministers). 1997. Criteria and indicators of sustainable forest management in Canada. Technical Report. Online: http://www.ccfm.org/ci/pdf/tech/ci_e.pdf

Millenium Ecosystem Assessment. 2005. Ecosystems and human well-being: synthesis. Island Press, Washington, D.C. Online: http://www.millenniumassessment.org/en/Products.Synthesis.aspx

NRTEE (National Round Table on the Environment and Economy). 2003. Environment and sustainable development indicators for Canada. Ottawa, ON. Renouf Publising Co. Ltd. 92 p

Suter, G., B. Sample, D. Jones, T. Ashwood and J. Loar. 1995. Approach and strategy for performing ecological risk assessments for the US Department of Energy's Oak Ridge Reservation: 1995 Revision. Prepared by the Environmental Restoration Risk Assessment Program for the US Department of Energy Office of Environmental Management. ES/ER/TM-33/R2.

Methodology

Figures 12.1, 12.2, Table 12.1

Sources

- Populated Places. Natural Resources Canada, Atlas of Canada. 1:1,000,000. 2003
- 2001 Census of Canada. Statistics Canada
- Secondary,Tertiary and Quaternary Watersheds. OMNR. 1:20,000. 2002.
- Global Forest Watch Canada. Forest Tenures in Canada.
- Environment Canada & Agriculture Canada. Terrestrial Ecoregions of Canada.

Methodology

- The regional view (Figure 12.1) displayed all data as found, without modification
- The tenure-based view (Figure 12.2; Table 12.1) utilized the 2001 Census figures to set precise population values for communities located within Gordon Cosens Forest, as the Populated Places dataset contains only coded population ranges for communities, and included several "No Data" values for this area

FLOOD CONTROL AND DROUGHT ALLEVIATION

HIGH CONSERVATION VALUE 4, QUESTION 13

Are there forests that provide a significant ecological service in mediating flooding and/or drought, controlling stream flow regulation, and water quality?

BACKGROUND

The HCVF Framework for Canada recognizes that forest areas play a critical role in maintaining water quantity and quality and that if these ecological services break down, they may be irreplaceable or there may be catastrophic impacts.

Canadian boreal forests perform numerous critical functions that help sustain life on earth, including filtering millions of litres of fresh water each day, producing oxygen, storing carbon and regulating local climatic process such as rainfall patterns (MEA 2005). More than 80% of world's unfrozen fresh water is found in the boreal. The Canadian boreal region includes one quarter of the earth's wetlands and approximately 1.5 million lakes that cover 30% of the region. These lakes and wetlands hold back floodwaters and release needed water throughout watersheds via rivers and streams.

We have identified three principal issues related to how this question has been addressed in HCVF assessments to date:

1. Multi-scaled spatial analysis: A multi scaled spatial analysis is a necessary element of a hydrologic analysis. Maps depicting the results of the analyses are vitally important for communicating results within the HCVF assessment document.

2. Cumulative effects: Climate, forest management actions, natural disturbances (*e.g.*, fire, beaver, landslides) and urbanization are all dynamic factors that influence water quality and quantity. Floods are usually attributable to unusual or extreme meteorological events, however other factors including removing forest cover and soil degradation may contribute.

3. Focus on management actions: Within existing assessments there is a tendency to explain that current forest management practices related to water quality and flow regulation (*e.g.*, stream crossings) are conducted within accepted guidelines or codes. Management regimes can change and should not be determining factors in HCVF identification; an analysis of forest areas providing water flow regulation or water quality services is still required to determine if any HCVF areas exist within the forest tenure.

DATA SOURCES

The HCVF Framework for Canada lists the following possible data sources:

- Hydrological maps
- Hydrologists in government departments or local research institutions

Additional data sources that would be relevant to addressing the issue of flood control and drought alleviation include:

- Local terrain mapping and base maps showing topography
- Regional watershed plans and authorities (*e.g.*, Mattagami Region Conservation Authority)
- Provincial watershed maps, including Provincially Significant Wetlands (Ontario)
- Ducks Unlimited Canada – wetlands and hydrological data
- Regional studies on flood events and frequencies
- Alberta Environment flood risk map http://www3.gov.ab.ca/env/water/flood/
- Environment Canada water level and stream flow statistics for specific stream monitoring stations http://www.wsc.ec.gc.ca/staflo/
- Manitoba water information maps http://www.gov.mb.ca/waterstewardship/water_info/maps/
- Snow, frozen soils and permafrost hydrology in Canada, 1995-1998 (Woo *et al*. 2000)

INTERPRETING REGIONAL AND LOCAL SIGNIFICANCE

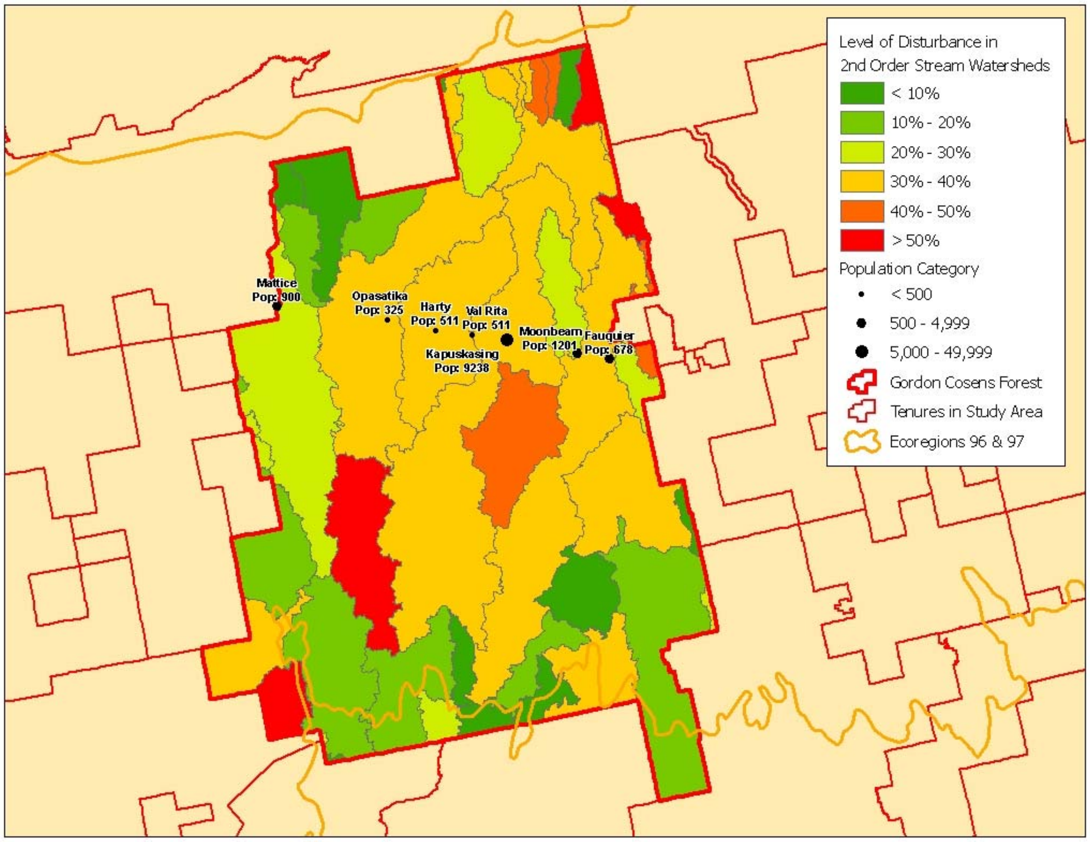
Forest harvest may alter basin hydrology on a regional scale. Within a watershed, the specific effects of forest harvest and other management actions are related to the slope and soil depth of the modified landscapes. Removal of forest cover reduces the lag time between a precipitation event and stream flow response, and increases the tendency for overland flow of water rather than infiltration. A generally proportional relationship exists between total water yield (*i.e.* runoff) and the extent of forest disturbance (Sahin and Hall 1996).

Identifying what forest areas are important for flood control and drought alleviation requires an understanding of regional and local hydrologic features and systems. A hydrological assessment should be the first step toward fully addressing both Questions 12 and 13.

Drought and natural floods are driven by atmospheric events, therefore it is similarly important to understand regional and local climate history and flood regimes. Prolonged periods of moderate rainfall can lead to plain floods that build up over days and can affect large areas, whereas short lasting but intense rainfall or snowmelt may cause flash flooding.

HCV4 Q13 – FLOOD CONTROL AND DROUGHT ALLEVIATION

Figure 13.1 Quaternary watersheds in Gordon Cosens Forest symbolized by level of disturbance within headwater areas (1st and 2nd order stream watersheds).



INTERPRETING THE PRECAUTIONARY PRINCIPLE

Analyses of forest areas important for flood control and drought alleviation should consider cumulative impacts of forest management, other land uses and natural disturbances. For example, post fire flooding is common and related impacts can result in sediment loading into rivers, streams and wetlands. The potential cumulative impact of a 100 year flood and forest management actions should be considered.

In addition, forest flooding regimes may change as a result of river regulation and water management associated with hydroelectric development. Finally, climate change is expected to increase total rainfall, rainfall intensity and soil erosion rates in North America (Nearing *et al*. 2004). To be precautionary, we recommend a water quantity monitoring program be established for HCVs identified under Question 13.

ADDITIONAL GUIDANCE

Identifying forest areas that have high conservation value because of their role in retaining water quality and quantity is aided by an understanding of flood, drought and water quality history. Climatic and hydrological records should be examined over as long a temporal scale as possible (e.g, 100, 50, 10 and 25 year flood records). In cases where records are poor or lacking a modeling approach based on topography and climate data may be necessary.

Hydrologic modeling programs that may be useful include:

- European Commission LISFLOOD model - developed to simulate floods in large European drainage basins. Allows full basin-scale simulations including influences of land use, spatial variations of soil properties and spatial precipitation differences (http://natural-hazards.jrc.it/floods/Tools/index)
- Danish Hydraulic Institute for Water and Environment MIKE 11 software package - is a versatile and modular engineering tool for modeling conditions in rivers, lakes/reservoirs, irrigation canals and other inland water systems. It is designed for flood risk analysis and mapping, design of flood alleviation systems, integrated groundwater and surface water analysis, and other hydrologic analyses (http://www.dhisoftware.com/mike11/index.htm)

If a comprehensive hydrological analysis is not feasible, we recommend a spatial analysis of all hydrologic features, including wetlands and secondary, tertiary and quaternary watersheds within the forest tenure.

HCV4 Q13 – FLOOD CONTROL AND DROUGHT ALLEVIATION

Table 13.1 Population centres in Gordon Cosens Forest and levels of 2nd order stream watershed disturbance.

3' WATERSHED	4' WATERSHED	TOTAL AREA OF 4' WATERSHED (HA)	PROPORTION OF 4' WATERSHED IN GORDON COSENS	LEVEL OF DISTURBANCE IN 2ND ORDER STREAM WATERSHEDS	COMMUNITY	POP'N	TOTAL POP'N IN 4' WATERSHED
4LD	4LD-01	198,389	98.0%	37.8%	Fauquier	678	678
4LF	4LF-01	264,997	100.0%	35.0%	Val Rita Kapuskasing	511 9,238	9,749
	4LF-02	34,857	100.0%	26.3%	Moonbeam	1,201	1,201
	4LF-03	106,712	100.0%	31.5%	Harty	511	511
4LJ	4LJ-01	174,336	81.5%	25.5%	Mattice	900	900
4LL	4LL-01	208,634	84.4%	30.7%	Opasatika	325	325

This approach is one way to identify flood-prone areas (*i.e.* riverine areas where flow is restricted), catchment basins and other forest areas critical to flood control, drought alleviation and maintaining water quantity. We recommend that direct measurements of hydrology (water level, trends, timing and in-stream flow) be used as indicators of water quantity.

Water flow may change in response to disturbance of forest vegetation and soils. Pairing an analysis of hydrologic features with an examination of the level of disturbance within 1st and 2nd order streams within the forest tenure will further aid in identifying areas prone to flooding or drought.

For example, Figure 13.1 shows the 4' watersheds in GCF symbolized by their level of 2nd order stream watershed disturbance. Table 13.1 describes the level of disturbance in the headwaters (1st & 2nd order stream watersheds) of each 4' watershed within the Gordon Cosens. Disturbance was measured as the proportion of the "headwater" area that was covered by recent depletions, or was within 100m of primary & secondary roads, or was within 50m of a tertiary (logging) road. Those watersheds with higher levels of anthopogenic disturbance should be listed as HCVFs due to their higher susceptibility to flooding or drought events.

Note that Table 13.1 links to the analysis described for Question 12 by providing a summary of the watersheds with communities, the total populations per watershed and the level of disturbance present in each watershed's "headwater" areas (*i.e.* 2nd order stream watersheds). The proportion of disturbance in populated watersheds ranges from about 25% up to nearly 40%. The average disturbance figure for all of the watersheds within Gordon Cosens, is approximately 25%.

Thresholds

One threshold for a measurable response in water flow as a result of forest disturbance was found to be at forest cover changes at or above a 20-25% (Bosch & Hewlett 1982; Hornbeck *et al.* 1993). We suggest a threshold of 20% disturbance (as defined above) be set for forest practices in all watersheds, and a precautionary threshold of 0-10% be set for HCVFs identified under this criteria.

Stream crossing density – the number of times that roads, trails, pipelines and railroads cross streams – is another potential watershed indicator. Watersheds with many crossings are more likely to have increased erosion, water temperature, angling pressure and temporary or permanent barriers to fish movement. Salmo (2004) recommends a critical threshold of <0.5 km/km^2 calculated for subwatershed, and target threshold of <0.32 km/km^2 per subwatershed for the Deh Cho Land Use Planning Area. We suggest a similar threshold is appropriate for HCVFs under Questions 12 and 13 throughout the Canadian boreal region.

It should again be emphasized that these thresholds should not be assessed against forestry practices alone, but should be measured against the total sum of all anthropogenic stresses. This cumulative impact is more indicative of the state of the watershed than a series of individual indicators.

Related HCVF questions/areas of possible overlap

- Question 12 – drinking water supplies
- Question 14 – forest areas sensitive to erosion
- Question 16 – forest areas important for agriculture or fisheries

SUMMARY OF RECOMMENDATIONS

- Conduct multi-scaled spatial analyses of hydrologic features and function and provide maps depicting the results of the analyses.
- Consider cumulative impacts from climate, forest management actions, other land uses and natural disturbances water quality and quantity.
- Identify HCVs based on inherent conservation value, not on management actions
- In cases where records are poor or lacking use a modeling approach based on topography and climate data to address this question.
- Establish a water quantity monitoring program for HCVs identified under Question 13.

HCV4 Q13 – FLOOD CONTROL AND DROUGHT ALLEVIATION

LITERATURE CITED

Bosch, J.M. and J.D. Hewlett. 1982. A review of catchment experiments to determine the effect of vegetation changes on water yield and evaportranspiration. J of Hydrology. 55:3-23.

Hornbeck, J.W., M.B. Adams, E. Corbett, E. Verry, J. Lynch. 1993. Longterm impacts of forest treatments on water yield: a summary for northeastern USA. J. of Hydrology 150:323-344.

Millenium Ecosystem Assessment. 2005. Ecosystems and human well-being: synthesis. Island Press, Washington, D.C. Online: http://www.millenniumassessment.org/en/Products.Synthesis.aspx

Nearing, M., F. Pruski and M. O'Neal. 2004. Expected climate change impacts on soil erosion rates: A review. Journal of Soil and Water Conservation 59(1):43-50.

Sahin, V., and M. Hall. 1996. The effects of afforestation and deforestation on water yields. Journal of Hydrology 178.293-309.

Salmo Consulting Inc. 2004. Deh Cho Cumulative Effects Study. Phase I: Management Indicators and Thresholds. Prepared for Deh CHo Land Use Planning Committee, For Providence, NWT. 151 p. Online: http://www.dehcholands.org/reports_cumulative_effects_report.htm.

Suter, G.W., B.E. Sample, D.S. Jones, T.L. Ashwood and J.M. Loar. 1995. Approach and strategy for performing ecological risk assessments for the US Department of Energy's Oak Ridge Reservation: 1995 Revision. Prepared by the Environmental Restoration Risk Assessment Program for the US Department of Energy Office of Environmental Management. ES/ER/TM-33/R2.

Woo, M.K., P. Marsh and J. Pomeroy. 2000. Snow, frozen soils and permafrost hydrology in Canada, 1995-1998. Hydrological Processes. 1591-1611

METHODOLOGY

Figures 13.1, Table 13.1

Sources

- Populated Places. Natural Resources Canada, Atlas of Canada. 1:1,000,000. 2003
- 2001 Census of Canada. Statistics Canada
- Secondary,Tertiary and Quaternary Watersheds. OMNR. 1:20,000. 2002.
- Road Segments. NRVIS layer. OMNR.
- Global Forest Watch Canada. Forest Tenures in Canada.
- Environment Canada & Agriculture Canada. Terrestrial Ecoregions of Canada.

Methodology

- 2001 Census figures were used to set precise population values for communities located within Gordon Cosens Forest, as the Populated Places dataset contains only coded population ranges for communities, and included several "No Data" values for this area
- Level of disturbance within each Quaternary watershed was estimated as the proportion of non-permanent, anthropogenic disturbance within the second-order stream watersheds for the portion of each Quaternary watershed within Gordon Cosens Forest
- The second order stream watershed layer was first intersected with the Quaternary watersheds and Gordon Cosens Forest Tenure
- The disturbance layer was calculated using the same methodology as Figure 7.2, utilizing depletion layers for Gordon Cosens Forest, and NRVIS roads data (applying 50m buffer to tertiary roads, and 100m buffer to primary and secondary roads)
- The level of disturbance was expressed as a proportion of the second order stream watersheds covered by the disturbance layer, and was used to populate Table 13.1, and this value was also used to symbolize the quaternary watersheds illustrated in Figure 13.1. It should be noted that due to data limitations, only the portions of watersheds that intersected Gordon Cosens Forest were analyzed, and disturbance levesl reflect these portions only.

EROSION CONTROL

HIGH CONSERVATION VALUE 4, QUESTION 14

Are there forests critical to erosion control?

BACKGROUND

The HCVF Framework for Canada recognizes that forests may be critical for soil, terrain or snow stability, including control of erosion, sedimentation, landslides, or avalanches.

Soil is a critically important resource on forest lands. Soil loss through erosion reduces a site's productivity through loss of nutrients and the ability to hold water. Soil erosion also negatively impacts down-slope ecosystems. Eroded soil washes into streams, rivers, and lakes and creates water quality problems for people, fish, and wildlife.

Soil erosion, including mass wasting, is the most common natural landscape forming process. Over thousands of years, natural erosion wears down mountains and deposits soil elsewhere to form plains, plateaus, valleys, river flats, and deltas. Accelerated erosion can result from certain human land use practices and requires a combination of two factors: Loose soil (resulting from moving water, raindrops, or freezing and thawing) and a physical force (*e.g.*, water, wind, ice, or gravity) that can transport the soil to a new location.

Several factors influence whether soil particles are likely to be loosened or detached and, thus, become vulnerable to erosion. These factors include:

- Force, frequency and timing of precipitation – Intense rains have more power to dislodge and transport soil than gentle rain does. Precipitation on frozen ground is less erosive than on unfrozen ground.
- Amount of vegetation and litter cover – Plants and litter provide cover that intercepts and reduces rainfall impact and slows wind velocities. Vegetation also increases water infiltration into the soil, reduces runoff velocities, filters sediment and contaminants and provides structure (roots) to hold the soil in place.
- Soil texture - silts and sands detach easily, while high clay content binds particles.
- Slope stability

Slope stability is affected by:

- Steepness - Generally, the steeper a slope the more susceptible it is to erosion and landslides
- Aspect – Slope facing into prevailing winds can lead to greater exposure to wind-driven rains, and higher run-off rates.
- Shape - Straight and S-shaped slopes tend to be more stable than concave or convex slopes
- Water content of the slope - Slopes saturated with water due to precipitation or human activities like irrigation or removal of vegetation can be too heavy to withstand down-slope movement.
- Slope modification- Slopes that are undercut by human activities, such as roads and excavation, may be unstable. Steep canyon slopes may be undercut by the erosive actions of streams. Structures or material deposited on the top of slopes may contribute to an overloading that encourages down-slope movement.

A generally proportional relationship exists between total water yield (runoff) and the extent of forest disturbance (Sahin and Hall 1996). The amount of erosion that occurs is a response to the balance between gravity and the resistance of soils, rock and, vegetation. Activities such as road building and timber harvesting can affect the ability of soils, rock, and vegetation to resist movement.

Avalanches

Avalanches commonly snap tree boles and move debris down slope and into watercourses.

Slope angle is one of the primary factors contributing to avalanche probability. Under most snow and weather conditions avalanches are rare on slopes less than 30 degrees, and are most common on slopes of 35-45 degrees. Slopes steeper than 50 degrees tend to slough snow and not build up a snowpack capable of avalanche. Dense trees and dense, large rocks act as anchors for snow on slopes. A thick, mature grove of conifers can act as an effective anchor for snow while a sparse grove of aspen or other deciduous species has very little effect.

DATA SOURCES

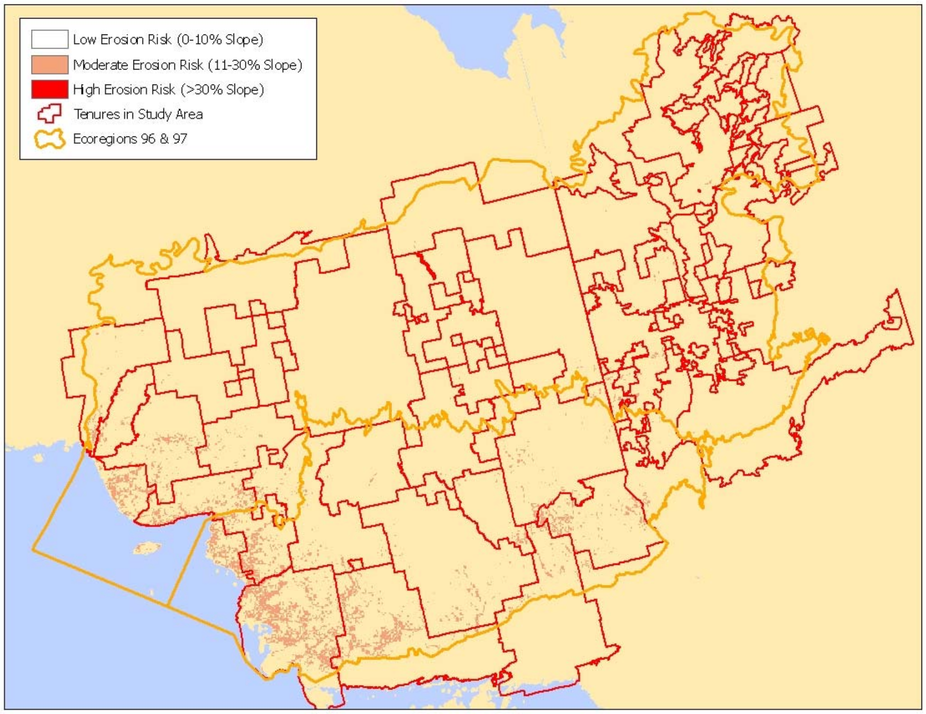
The HCVF Framework for Canada lists the following possible data sources:

- Maps, remote sensing data, aerial photos, Governmental departments
- Consultation with relevant experts

Additional data sources that would be relevant to addressing the issue of erosion control include:

- Regional guidelines (*e.g.* Ministry of Natural Resources in Ontario) on physical environment and erosion risks
- British Columbia Watershed Assessment Procedures (http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/Guidetoc.htm)
- Slope data from topographic maps
- Digital Elevation Models (*e.g.* USGS SRTM 90m DEM http://seamless.usgs.gov/. This dataset has extensive coverage, but its resolution may not be

Figure 14.1 Slope analysis of the study area.



suitable for finer scale analyses. Practitioners should make use of the finest scale data available for their land base.)

- Soil landscapes of Canada 1:1 million scale (http://sis.agr.gc.ca/cansis/nsdb/slc/index.html)
- Ontario – NOEGTS landform database
- District soils maps (available on-line for some regions; http://sis.agr.gc.ca/cansis/nsdb/detailed/index.html)
- Snow, frozen soils and permafrost hydrology in Canada, 1995-1998 (Woo *et al*. 2000)

INTERPRETING THE PRECAUTIONARY PRINCIPLE

Cumulative impacts of various land uses and natural disturbances may result in accelerated soil erosion and mass wasting (Carignan *et al.* 2000). For example, after severe fires, soils are no longer protected by vegetation cover and are subject to accelerated erosion rates. The erosive impact of water on bare post-fire soils is accelerated by even moderate precipitation events. Infiltration rates decrease on bare slopes causing increased runoff and accelerated sediment carrying capacity. The resulting sediment and debris movement into stream channels causes clogging within the channels and mud and debris flows, which scour steeper channel segments and encourage significant deposition along flatter areas of the stream corridor. To compound the hazard potential, soils are subject to slipping or slumping during rainy periods when super saturation may occur. Once super saturated with water, denuded soils lose their cohesive strength and are subject to sloughing.

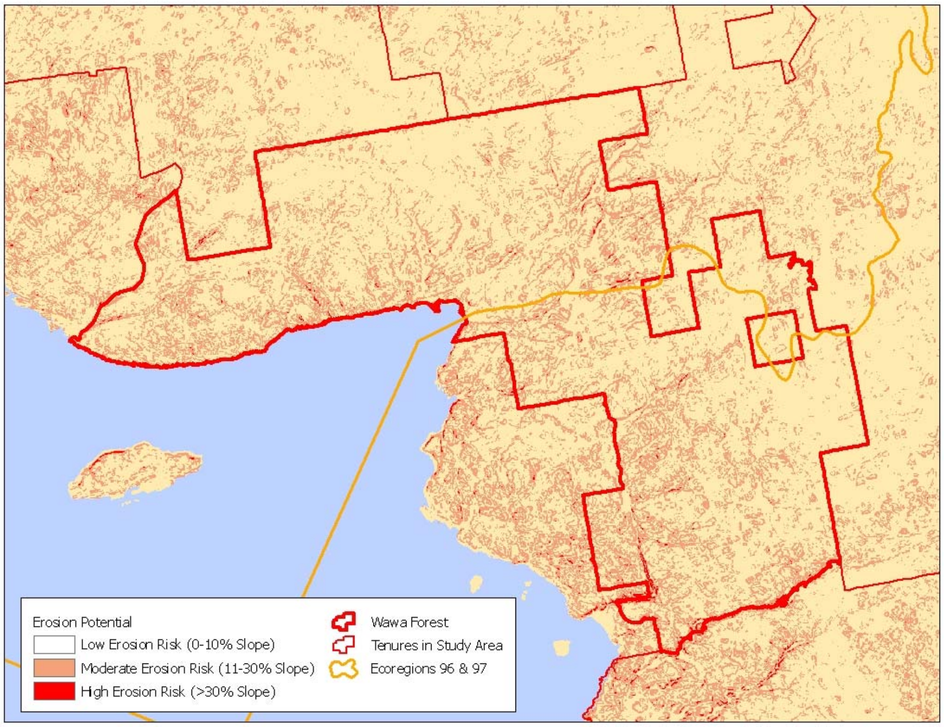
Under the precautionary principal, we recommend analyses of erosion-prone areas include potential cumulative impacts of forest management actions, other land uses and natural disturbances. Climate change is expected to increase total rainfall, rainfall intensity and soil erosion rates in North America (Nearing *et al*. 2004). To be precautionary, analyses of erosion prone areas within FMAs should be re-evaluated at least once per decade.

ADDITIONAL GUIDANCE

Spatially modeling erosion and/or flood probability is a common method of identifying erosion prone areas. The flood modeling approaches discussed under Question 13 in this document may also be useful for modeling erosion (see Question 13).

Modeling erosion using the Revised Universal Soil Loss Equation (RUSLE) may also be useful. The RUSLE computes sheet and rill erosion from rainfall and the associated runoff for a landscape profile. It is based on the Universal Soil Loss Equation (Wischmeier and Smith 1978), which incorporates factors for rainfall erosivity, soil erodibility, slope length and steepness, vegetative cover and management and conservation practices. The publicly available RUSLE2 software model (developed by the US Natural Resources Conservation Service) predicts long-term, average-annual erosion by water. While RUSLE2 was developed to be land use independent, note that some researchers question its applicability to certain forest soils and slope gradient characteristics (Gonzalez-Bonorion and Osterkamp 2004). Note also that for some areas of the Canadian boreal region

Figure 14.2 Slope analysis of the Wawa Forest.



adequate, fine-scale data may not be available to use this approach successfully for identifying erosion risk areas.

For more information on RUSLE erosion prediction technologies and current software see: http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm?action=Go+to+the+official+NRCS+RUSLE2+website

For areas lacking fine-scale data, erosion potential can be mapped based on slope angle by deriving slope from digital elevation models, and erosion potential based on regional guidelines. Figure 14.1 illustrates this example for the study area. Given that there is a lack of fine scale soils data, and that the OMNR guidelines indicate little variability in erosion risk across soil types (OMNR 1997), we based this analysis on slope values only using a 90 m resolution digital elevation model.

It should be noted that while the use of a 90 m or comparable resolution DEM is adequate for analyses at the regional scale, investigations at the level of the management unit should ideally utilized finer grained data. An intrinsic characteristic of slope analyses using DEMs is the decrease in average slopes identified with increasing grid size, potentially leading to underestimations of erosion potential (Montgomery 2003).

Figure 14.2 illustrates the same analysis at the scale of a single tenure located in the southwest of the study area, the Wawa Forest. This analysis, while useful in highlighting the general areas of high erosion risk, does not produce defined HCVF zones delimiting the erosion prone sites.

To determine a mappable distribution of erosion sensitivity, it is more useful to derive threshold levels of erosion risk within defined ecological or management-based units. We derived a threshold for the proportion of Forest Resource Inventory (FRI) polygons at medium and high erosion risk according to the following values:

- > 75% of the FRI polygon is medium and/or high erosion risk; or
- > 50% of the FRI polygon is high erosion risk

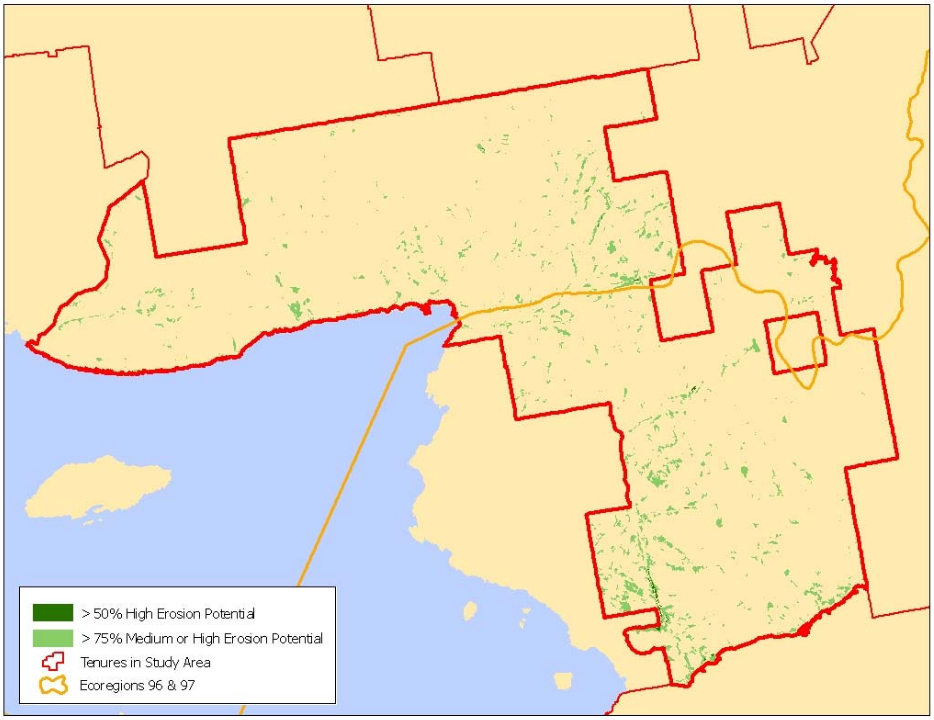
Figure 14.3 illustrates the distribution of medium and high risk FRI stands in Wawa forest with these thresholds applied.

We recommend that management prescriptions vary depending on the amount of medium and high erosion prone slopes. For FMAs with steep terrain, we recommend a similar analysis of slope angles to identify avalanche-prone slopes.

Thresholds

One threshold for a measurable response in water flow as a result of forest disturbance was found to be at forest cover changes at or above a 20-25% (Bosch and Hewlett 1982; Hornbeck *et al* 1993). Under Question 13 in this document we suggest a threshold of 20% disturbance (as defined above) be set for forest practices in all watersheds, and a precautionary threshold of 0-10% be set for HCVFs identified under

Figure 14.3 Potential HCVFs defined by FRI polygons which are covered by greater than 50% high erosion potential areas or greater than 75% medium and/or high erosion potential areas.



Question 13. We recommend this threshold also apply with regard to erosion probability.

Stream crossing density – the number of times that roads, trails, pipelines and railroads cross streams – is another potential watershed indicator. Watersheds with many crossings are more likely to have increased erosion, water temperature, angling pressure and temporary or permanent barriers to fish movement. Salmo (2004) recommends a critical threshold of <0.5/km^2 calculated for subwatershed, and target threshold of <0.32/km^2 per subwatershed for the Deh Cho Land Use Planning Area. We suggest a similar threshold is appropriate for HCVFs under Questions 13 and 14 throughout the Canadian boreal region.

R*elated HCVF questions/areas of possible overlap*

- Question 12 – drinking water supplies
- Question 13 – forest areas important for flood control and drought alleviation
- Question 16 – forest areas important for agriculture or fisheries

SUMMARY OF RECOMMENDATIONS

- Include potential cumulative impacts of forest management actions, other land uses and natural disturbances analyses of erosion-prone areas.
- Consider basing an analysis of erosion and avalanche risk on slope angle derived from a DEM.
- Vary management prescriptions depending on the amount of medium and high erosion prone slopes.

LITERATURE CITED

Archibald, D., W. Wiltshire, D. Morris and B. Batchelor. 1997. Forest management guidelines for the protection of the physical environment. OMNR. 42 p.

Carignan, R., P. D'Arcy and S. Lamontagne. 2000. Comparitive impacts of fire and forest harvesting on water quality in Boreal Shield Lakes. Canadian Journal of Fisheries and Aquatic Science 57:105-117.

Gonzalez-Bonorion, G. and W.Osterkamp. 2004. Applying RULSE 2.0 on burned-forest lands: An appraisal. Journal of Soil and Water Conservation 59(1): 36-42

Montgomery, D. 2003. Predicting landscape-scale erosion rates using digital elevation models. Comptes Rendu Geoscience 335 (16): 1121-1130

Nearing, M., F. Pruski and M. O'Neal. 2004. Expected climate change impacts on soil erosion rates: A review. Journal of Soil and Water Conservation 59(1): 43-50

Sahin, V., and M. Hall. 1996. The effects of afforestation and deforestation on water yields. Journal of Hydrology 178.293-309.

Salmo Consulting Inc. 2004. Deh Cho Cumulative Effects Study. Phase I: Management Indicators and Thresholds. Prepared for Deh CHo Land Use Planning Committee, For Providence, NWT. 151 p. Online:

http://www.dehcholands.org/reports_cumulative_effects_report.htm.

Wischmeier, W. and D. Smith. 1978. Predicting rainfall erosion losses- a guide to conservation planning. Agriculture Handbook No. 537. US Department of Agriculture, Washington, DC.

Woo, M., P. Marsh and J. Pomeroy. 2000. Snow, frozen soils and permafrost hydrology in Canada, 1995-1998. Hydrological Processes. 1591-1611

METHODOLOGY

Figures 14.1, 14.2, 14.3, 14.4

Sources

- SRTM 90 m Digital Elevation Model. USGS. http://seamless.usgs.gov/; Note this dataset was utilized do its availability and widespread coverage. Analysis done on individual tenures should take advantage of the finest scale DEM available for the land base.
- Global Forest Watch Canada. Forest Tenures in Canada.
- Environment Canada & Agriculture Canada. Terrestrial Ecoregions of Canada.

Methodology

- The SRTM 90 m DEM was converted to a grid of percent slope and clipped to the Study Area (Terrestrial Ecoregions of Canada, Ecoregions 96 and 97)
- The percent slope grid was re-classified to illustrate the erosion risk classes cited in Archibald *et al.* (1997) to create Figure 14.1
- Figure 14.2 illustrates the same grid of percent slope viewed at the scale of the Wawa Forest
- The "hotspot" analysis of the Wawa Forest area was performed using a neighbourhood analysis of the percent slope grid using a circular neighbourhood with a 1 km radius to calculate the mean value at each cell creating Figure 14.3
- The slope grid for Wawa Forest was reclassified to "medium" and "high" erosion potential classes, using the above thresholds. This was done to facilitate the conversion of the grid to a polygon coverage.
- The polygon coverage of erosion potential was then intersected with the Forest Resource Inventory polygons for Wawa Forest, and the resulting layer was used to tabulate the proportion of each stand which fell into medium or high erosion classes. This information was used to symbolize Figure 14.4.

FIRE BARRIER

HIGH CONSERVATION VALUE 4, QUESTION 15

Are there forest that provide a critical barrier to destructive fire (in areas where fire is not a common natural agent of disturbance)?

BACKGROUND

The HCVF Framework for Canada states: "This issue was raised by tropical forest ecologists and the writing team cannot identify any forest ecosystems in Canada where this basic service can be provided. However, we are leaving this item until consultation and/or application confirms its relevance."

The basis of the specific framework question clearly does not apply well to boreal forests, where fire is not only common, but is a critically important, pervasive natural disturbance. Indeed, boreal forests especially in western North America are structured by large wildfires (Johnson *et al* 1998, Weber and Stocks 1998). Fire in the boreal region has important social, economic, and ecological effects and thus we suggest that natural fire patterns should be considered when identifying areas of high conservation value and in developing best practices for forest management.

Change in forest composition or climate, fire suppression or loss of riparian forests could all impact forest fire dynamics in any boreal region. Indeed, natural fire barriers are relevant in determining naturally patchy patterns of fires in the boreal. These natural barriers include riparian vegetation, wetland soils, lake margins, and in some cases, ridge tops. Likewise more fire prone areas within the forest, including jack pine, lodgepole pine and black spruce stands and sites with sandy soils are equally important for maintaining the dynamic and patchy nature of fire on boreal landscapes. Maintaining fire and other natural disturbance regimes is an important factor in natural forest regeneration, maintaining diverse wildlife habitats, and perpetuating a fully functional ecosystem – in short, for maintaining a diversity of high conservation values within boreal forest ecosystems.

Further, as more forestland is developed with industrial infrastructure and as communities within and adjacent to forests grow, the possibility of destruction from uncontrolled fires increases and wildland fire management becomes more challenging. Often the response in these situations is to suppress fire, ultimately leading to decreased forest productivity and ecological conditions that are outside the range of natural variation. Contrary to popular belief, fire suppression in boreal forests where closed canopy ecosystems and crown-fire regimes dominate, may not lead to increased fuel loads and create conditions for catastrophic fires (Johnson *et al.* 2001).

There are likely limited cases in which forest areas in Canada will be identified as a "critical barrier to destructive fire". Rather, in this section, we consider two general areas of investigation that may lead to the identification of HCVFs related to fire dynamics. One issue to consider is whether the trend in fire disturbances is within natural ranges of variation. Related to this, a spatial assessment of fire risk or potential (*e.g.* whether forest areas are more fire-prone or are fire breaks) and active fire suppression may help to determine whether particular forest areas play a role in a healthy fire cycle.

DATA SOURCES

Data sources that would be relevant to addressing the issue of forest areas as a barrier to fire in critical situations include:

- Regional fire histories
- Regional or local fire boundary maps
- Historical aerial photography
- Soils maps
- Hydrologic features maps
- Biogeoclimatic Ecosystem Classification (BEC) in BC: http://www.for.gov.bc.ca/hre/becweb/

The Canadian Forest Service provides a variety of resources for understanding and predicting wildland fires:

- Large scale fire Regime Analysis for Saskatchewan: http://fire.cfs.nrcan.gc.ca/research/management/ifm/regime_e.htm
- SPARKY - Lightning-Caused Fire Occurrence Prediction Model (for Quebec and BC): http://fire.cfs.nrcan.gc.ca/research/management/fop/sparky_e.htm
- PEOPLENET - Ecoregion/Ecodistrict People-Caused Fire Occurrence Prediction Model (for Quebec): http://fire.cfs.nrcan.gc.ca/research/management/fop/peoplenet_e.htm
- Predicting Future Fire Regimes- Incorporating Fire Occurrence Prediction with Regional Climate Model (RCM) Projections to Predict Future Fire Regimes http://fire.cfs.nrcan.gc.ca/research/management/fop/rcm_e.htm

ADDITIONAL GUIDANCE

Natural disturbance regime of the region

Sustainable forest management requires a thorough understanding of current and past natural disturbance patterns including regional fire regimes.

A region's fire regime is defined according to the characteristics of natural fires including intensity, frequency, severity, season, extent, duration, behaviour, spatial distribution, and type of fire. Fire regime characteristics are the result of many different factors (*e.g.*, climate, vegetation composition, landform, *etc.*) operating at different spatio-temporal scales. The fire regime may differ markedly between ecozones and ecoregions. For example, the fire cycle values of the three ecozones in Saskatchewan are 267, 98, and 114 years for the Boreal Plain, Boreal Shield, and Taiga Shield, respectively (CFS 2004).

Vegetation composition and seral class distributions are useful for predicting likely fire size and distribution at a local and regional scale. For example, Cumming (2001) developed a parametric model to predict the distribution of large fire sizes within boreal forests. Within his study region of boreal mixedwood forests in Alberta, Cumming found that the expected size of a fire is positively related to the abundance of pine-dominated stands in the vicinity of ignition, and negatively related to the abundance of previously disturbed areas. This type of analysis paired with a predictor of ignition (*e.g.*, The Wildfire Ignition Probability Predictor System (WIPP) developed by the Canadian Forest Service (CFS): http://fire.cfs.nrcan.gc.ca/research/management/fop/wipps_e.htm) can help managers identify fire prone areas within an FMA.

What HCVs and processes are dependent on fire or shaped by fire

Rare ecosystems, intact forest blocks, certain plant and animal species, forest regeneration, and other processes in boreal forests may be dependent on or shaped by fire. We recommend a cumulative effects analysis of all HCVs identified within an FMA relative to fire regime, including fire frequency and likely burn pattern. This analysis is part of what we recommend for Question 19 in this paper, and may be conducted while addressing Question 19.

Understand what actions change fire regime

Fire suppression, human caused fires, introduction of non-native species and a decrease in mean fire size due to fragmentation are all factors that may contribute to alteration of natural fire regimes. A warmer climate is predicted to cause changes in fire regime, declines in some boreal forest communities and changes in the structure of others (Chapin *et al* 2004, Carcaillet *et al* 2001). We recommend these factors be included in an analysis of fire regime relative to HCVFs within a FMA.

Spatial assessment of fire risk

Identify fire prone vegetation and landforms within the FMA

Jack pine, lodgepole pine and black spruce are the most fire-prone boreal tree species. All are fire-adapted species with serotinous cones, high ignition rates and high flammability. Landforms and areas underlain by sandy soils and with abundant rock outcrops tend to be dry and the most fire prone within boreal forests. While relationships between ignition, seasonality and vegetation type are complex, these basic fire-prone vegetation types, soils and landforms are easily identified and mapped from Forest Resource Inventory (FRI) data and soils and geology maps, or can be derived from ecological classification systems such as the Biogeoclimatic Ecosystem Classification (BEC) in BC (see above).

A larger scale approach to this question is to identify and map areas where there have been substantial changes in temperature and moisture regime. These changes will inform fire risk mapping based on stand and topographic parameters described above.

Identify natural and man-made fire barriers

Riparian areas including stream banks, floodplains, wetlands, islands and associated water bodies all act as natural fire barriers, and there is an inverse relationship between length of fire cycle and the mean distance to a water-break in boreal forests (Larsen 1997). During most of the natural fire season, early and mid-successional vegetation, including forbs and deciduous shrubs, saplings and trees have low ignition rates and low flammability. An exception exists during the early spring of most years in the North American boreal region when abundant sunlight and low humidity combine to create dry conditions prior to green-up and leaf-out.

Roads often create breaks in low intensity, ground and surface fires, but may not block the spread of high intensity crown fires. Likewise, seismic lines may or may not serve as fire breaks depending on the nature and condition of the vegetation and fire. Again, these features are easily identified and mapped from data that exists for most Forest Management Areas (FMAs).

The Wildland-Urban-Interface (WUI)

To maintain a fire regime within the range of natural variation it is important to consider the effect of fire suppression zones - known locations where fire will be suppressed if ignited. We recommend these areas be identified and mapped within FMAs.

SUMMARY OF RECOMMENDATIONS

Fire disturbances within natural ranges of variation:

- Understand the natural disturbance regime of the region and what actions may change the fire regime.
- Understand what HCVs and processes are dependent on fire or shaped by fire and conduct a cumulative impacts analysis

Spatial distribution of fire disturbance events:

- Identify fire prone vegetation and landforms within the FMA
- Identify natural and man-made fire barriers
- Consider the effect of fire suppression zones such as the Wildland-Urban-Interface.

LITERATURE CITED

CFS 2004. Canadian Forest Service. Large scale fire Regime Analysis for Saskatchewan: http://fire.cfs.nrcan.gc.ca/research/management/iffm/regime_e.htm

HCV4 Q15 – Fire Barrier

Carcaillet, C., Y. Bergeron, P.J.H. Richard, B. Frechette, S. Gauthier and Y.T. Paririe. 2001. Change in fire frequency in the eastern Canadian boreal forests during the Holocene: does vegetation composition or climate trigger the fire regime? J. of Ecology 89:930-946.

Chapin, S., T. Callaghan, Y. Bergeron, M. Fukuda, J. Johnstone, G. Juday and S. Zimov. 2004. Global change and the boreal forest: Thresholds, shifting states or gradual change? Ambio 33(6):361-365.

Cumming, S. 2001. Forest type and wildfire in the Alberta boreal mixedwood: what do fires burn? Ecological Applications 11:97-110

Johnson, E., K. Miyanishi, and S. Bridge. 2001. Wildife regime in the boreal forest and the idea of suppression and fuel buildup. Conservation Biology 15(6):1554-1557.

Johnson, E., K. Miyanishi and J. Weir. 1998. Wildfires in the Western Canadian Boreal Forest: Landscape patterns and ecosystem management. Journal of Vegetation Science 9: 603-610.

Larsen, C. 1997. Spatial and temporal variations in boreal forest fire frequency in northern Alberta. J of Biogeography 24, 663-673.

McRae, D., L. Duchesne, B. Freedman, T. Lynham and S. Woodley. 2001. Comparisons between wildlife and forest harvesting and their implications in forest management. Environ. Rev. 9:223-260.

Weber, M., and B. Stocks. 1998. Forest Fires and Sustainability in the Boreal Forests of Canada. Ambio 27(7): 545-550.

AGRICULTURE AND FISHERIES IMPACTS

HIGH CONSERVATION VALUE 4, QUESTION 16

Are there forest landscapes (or regional landscapes) that have a critical impact on agriculture or fisheries?

BACKGROUND

The HCVF Framework for Canada recognizes that forests mediate wind and microclimate at the scale of ecoregions, affecting agricultural or fisheries production. The Framework further states: "Riparian forests play a critical role in maintaining fisheries by providing bank stability, sediment control, nutrient inputs, and microhabitats."

At the watershed scale, major environmental factors determining invertebrate and fish species distributions include watershed size, stream gradients, lake depths, conductivity, and percentage of the watershed covered by forest. Within specific stream reaches and lakes the distribution of fish is influenced by temperature, oxygen, current and availability of food. Activities such as clearings and road networks created for timber harvesting and other resource extraction can directly and indirectly affect one or more of these factors and change flow rates and patterns, sediment yield, stream habitat, invertebrates, and fisheries (Furniss *et al.* 1991, McGurk and Fong 1995, Trombulack and Frissell 2000, Foster *et al.* 2005). Water quality changes, including changes to thermal regimes, water chemistry, and invertebrate communities, may occur regardless if forest buffers are intact (Herunter *et al.* 2004) therefore it is important to assess forest areas for high conservation values related to drinking water quality (Question 12) and fisheries (Question 16) regardless of regulations requiring buffer areas.

The HCVF Framework for Canada further states that "more local effects of forest areas (e.g., adjacency of forests to agriculture and fisheries production) may be more relevant in the HCV component regarding meeting basic needs of local communities." Indeed, in some regions baitfish businesses and recreational and guided sport fisheries may be important elements of local economies. For example, many of the more than 60 species of fish recorded in northern Ontario sustain commercial baitfish, subsistence, and fly-in recreational fisheries in the region. This aspect of the HCVF assessment is more closely aligned with Question 17 (needs of local communities).

In this section we address how and why to identify fish populations and fish habitat within FMAs under HCVF assessment.

DATA SOURCES

The HCVF Framework for Canada lists the following possible data sources:

- Agricultural and Fisheries scientists in university and research institutions;
- Governmental Departments (e.g., Department of Fisheries and Oceans, Agriculture and Agri-food Canada);
- Local and provincial departments.

Additional data sources might include:

- Ontario: MNR NRVIS database
- Alberta: Cooperative Fisheries Inventory Program (CFIP); Fisheries Management Information System (FMIS)
- Local and District land use plans
- Local terrain mapping and base maps showing topography
- Regional watershed plans and authorities (*e.g.*, Mattagami Region Conservation Authority)
- Provincial watershed maps**,** including Provincially Significant Wetlands (Ontario)
- Ducks Unlimited Canada – hydrological and wetlands data

INTERPRETING GLOBAL, NATIONAL AND REGIONAL SIGNIFICANCE

Most fisheries and agricultural activities within boreal forest areas in Canada are likely to be either regionally or locally significant. The significance to communities and regions of sport, subsistence and commercial fisheries is best assessed through direct communication with local experts and community leaders.

INTERPRETING THE PRECAUTIONARY PRINCIPLE

Cumulative effects

Changes in the health of boreal fish populations are driven by three often-interacting factors: habitat loss, habitat alteration, and excessive fish harvest. Multiple industrial, residential and recreational land uses, changing climate, and natural disturbances may alter water quantity and quality and impact fisheries. In addition, competition with introduced and invasive species and fishing pressure (including poaching) contribute to declines in fisheries in the boreal region. For example, as the number of land uses has increased in Alberta, managers have measured significant changes in abundance and distribution of bull trout, grayling and other boreal fish species (Stelfox 2004).

Forest roads and trails may provide access to previously remote fish populations, increasing angler pressure and negatively impacting habitats and population numbers. Popowich and Volpe (2004) estimate poaching levels approached 17% in the Elbow River watershed in Alberta during September and October 2003. In all confirmed cases, fish were taken from areas easily accessed by foot or by off-highway vehicles.

HCV4 Q16 – AGRICULTURE AND FISHERIES IMPACTS

We recommend that fish population sensitivity, habitat sensitivity and potential cumulative effects be factored into an assessment of conservation value of fisheries. In cases where cumulative effects are poorly understood we further recommend that all sensitive habitats and populations be designated as HCV.

ADDITIONAL GUIDANCE

Identify existing fisheries and naturally occurring fish habitat

Existing fisheries are best identified by communicating with local and regional experts and leaders. We also recommend that all seasonal fish habitat (*e.g.*, spawning habitats, rearing habitats, winter habitats, etc.) be identified, mapped and considered for HCVF designation. If mapped information is not available, fish habitat can be identified through habitat suitability modeling based on requirements for specific habitat parameters (*e.g.*, depth, sediment type, current, etc) for regionally occurring fish species. Developing suitability indices for both juveniles and adults allows model indices to reflect changes in habitat use with age. By combining the spatial distribution of preferred habitat in a GIS, a predictive map of the location of important fish habitat can be produced.

Assess and monitor riparian condition

Riparian health is determined by the ability of a riparian site to perform specific ecological functions including:

- Trapping and storing sediment
- Building and maintaining banks and shores
- Storing water and energy
- Recharging aquifers
- Filtering and buffering water
- Source of large woody debris
- Maintaining biodiversity

Ambrose *et al.* (2004) have developed a riparian health assessment based on vegetative and physical characteristics of a riparian site that examines which of these ecological features are intact. Parameters included in their assessments include vegetative cover, bare soil, clearing and regeneration of tree and shrub communities, structural alterations to the bank or shore, site potential, and change in hydrologic regime or plant community that may impact the ability of the area to perform these ecological functions. Sites are rated based on vegetative and physical thresholds met or exceeded.

We recommend conducting similar riparian assessments for FMAs under HCVF assessment. Such evaluations not only help identify issues but also establish baselines for monitoring riparian health and the effects of management.

Thresholds

We recommend the following thresholds –- all recommended for either Questions 12, 13 or 14 in this document – also be applied for protecting fisheries:

<u>Forest disturbance and water quantity</u>

A generally proportional relationship exists between total water yield (runoff) and the extent of forest disturbance (Sahin and Hall 1996). A measurable response in water flow as a result of forest disturbance was found to be at forest cover changes at or above a 20-25% (Bosch and Hewlett 1982; Hornbeck *et al.* 1993). To ensure natural water flow patterns, we suggest a threshold of 20% disturbance be set for forest practices in all watersheds, and a precautionary threshold of 0-10% be set for HCVFs identified under this criteria. We further recommend that direct measurements of hydrology (water level, trends, timing and in-stream flow) be used as indicators of water quantity.

<u>Water quality</u>

We suggest that a set of water quality indicators be chosen and monitored for HCVFs identified under this category. These indicators may include turbidity, concentration of dissolved organic carbon or nutrients. Suter *et al.* (1995) proposed a threshold of 20% reduction in measured physical or chemical parameters as a significance standard for ecological risk assessment. We propose this 20% threshold be applied to HCVFs under Question 16.

<u>Stream crossings (water quality and quantity)</u>

Watersheds with many crossings are more likely to have increased erosion, water temperature, angling pressure and temporary or permanent barriers to fish movement. Therefore stream crossing density – the number of times that roads, trails, pipelines and railroads cross streams – is another potential watershed indicator. Salmo (2004) recommends a critical threshold of $<0.5/km^2$ calculated for subwatershed, and target threshold of $<0.32/km^2$ per subwatershed for the Deh Cho Land Use Planning Area. We suggest a similar threshold is appropriate for HCVFs under Questions 13, 14 and 16 throughout the Canadian boreal region.

Cumulative effects

It should again be emphasized that thresholds should not be assessed against forestry practices alone, but should be measured against the total sum of all anthropogenic stresses. This cumulative impact is more indicative of the state of the system than a series of individual indicators.

Related questions

Question 12 – Drinking water supplies
Question 13 – Flood and/or drought mediation
Question 14 – Erosion control
Question 17 – Needs of local communities

SUMMARY OF RECOMMENDATIONS

- Account for cumulative effects in assessments of conservation value of fisheries.

- In cases where cumulative effects are poorly understood designate all sensitive habitats and populations as HCV.
- Identify fish habitat through habitat suitability modeling based
- Asses the condition of riparian areas relative to thresholds for water quality and quantity.

LITERATURE CITED

Ambrose, N.E., A.D. Bogen, K. O'Shaughnessy, and K. Spicer-Rawe. 2004. Riparian health evaluation – tools for assessing the function of riparian areas. Pages 137-138 in G.J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins and M. Monita. Editors. Forest-Land-Fish Conference II – Ecosystem Stewardship through Collaboration. Proc. Forest-Land-Fish Conf. II, April 26-28, 2004, Edmonton, Alberta.

Bosch, J.M. and J.D. Hulet. 1982. A review of catchment experiments to determine the effect of vegetation changes on water yield and evaportranspiration. Journal of Hydrology 55:3-23.

Foster, N., F. Beall and D. Kreutzweiser. 2005. The role of forests in regulating water: the Turkey Lakes Watershed case study. The Forestry Chronicle 81(1):142-148

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction am maintenance. In: Meehan, W.R., ed. Influence of forest and rangeland management on salmonid fishes and their habitats. Bethesda, Maryland: American Fisheries society; pages 297-323.

Herunter, H.E., J.S. Macdonald, E.A. MacIsaac. 2004. Effectiveness of variable-retention riparian buffers for maintaining thermal regimes, water chemistry, and benthis invertebrate communities of small headewater streams in central British Columbia. Pages 105-113 in G.J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins and M. Monita. Editors. Forest-Land-Fish Conference II – Ecosystem Stewardship through Collaboration. Proc. Forest-Land-Fish Conf. II, April 26-28, 2004, Edmonton, Alberta. http://www.tucanada.org/forestlandfish2/cfp.htm

Hornbeck, J.W., M.B. Adams, et al. 1993. Longterm impacts of forest treatments on water yield: a summary for northeastern USA. Journal of Hydrology 150:323-344.

McGurk, B.J. and D.R. Fong. 1995. Equivalent roaded area as a measure of cumulative effect of logging. Environmental Management 19(4): 609-621

Salmo Consulting Inc. 2004. Deh Cho Cumulative Effects Study. Phase I: Management Indicators and Thresholds. Prepared for Deh CHo Land Use Planning Committee, For Providence, NWT. 151 p. Online: http://www.dehcholands.org/reports_cumulative_effects_report.htm.

Popowich, R.P. and J.P Volpe. 2004. Troubled waters: cumulative anthropogenic activitiy and a declining bull trout population. Pages 15-16 in G.J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins and M. Monita. Editors. Forest-Land-Fish Conference II – Ecosystem Stewardship through Collaboration. Proc. Forest-Land-Fish Conf. II, April 26-28, 2004, Edmonton, Alberta.

Sahin, V., and Hall, M.J. 1996. The effects of afforestation and deforestation on water yields. Journal of Hydrology 178.293-309.

Sutter, G.W., B.E. Sample, D.S. Jones, T.L. Ashwood and J.M. Loar. 1995. Approach and strategy for performing ecological risk assessments for the US Department of Energy's Oak Ridge Reservation: 1995 Revision. Prepared by the Environmental Restoration Risk Assessment Program for the US Department of Energy Office of Environmental Management. ES/ER/TM-33/R2.

Stelfox, B.J. 2004. The role of integrated land management to assist with exploring the past, present, and future effects of landscape activities on alberta;s boreal fish communities. Pages 9-10 in G.J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins and M. Monita. Editors. Forest-Land-Fish Conference II – Ecosystem Stewardship through Collaboration. Proc. Forest-Land-Fish Conf. II, April 26-28, 2004, Edmonton, Alberta.

Trombulack, S.C. and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14(1):18-30.

OVERLAPPING VALUES

INTERSECTION OF HIGH CONSERVATION VALUES, QUESTION 19

Is there a significant overlap of values (ecological and/or cultural) that individually did not meet HCV thresholds, but collectively constitute HCVs?

BACKGROUND

The analyses conducted throughout a High Conservation Value Forest assessment process are focussed on identifying values that are independently critical or outstanding. This approach to assessing the landscape is susceptible to overlooking areas in which there is a confluence of several values, which considered in isolation do not represent a significant contribution, but when looked at collectively meet the criterion of being critical or outstanding. This is the intent of Question 19 – to locate those areas of significant concentration of a given type of value or areas which contain the overlap of multiple values.

DATA SOURCES

The data inputs to the analyses for Question 19 should include all values considered for each of the preceeding 18 quesitons. This list should include all values assessed: those which were confirmed as HCVs; those which were found to be possible, potential or marginal; and those which were ruled out, but still present on the landscape (e.g. species at risk present or potentially present in the landscape but not in sufficient concentration). It is recommended that extra attention be given to delimiting and mapping all potential and marginal HCVs while they are being investigated in their respective focal Question, so as to facilitate their inclusion in the Question 19 analysis.

The inclusion of previously confirmed HCVFs in this analysis is intented to highlight opportunities to extend HCVF zones to capture neighbouring areas of concentration which may not have seemed relevent without their adjacency to "core" HCVF areas, or to potentially adjust their management strategies to accommodate the maintenance of secondary, overlapping values (e.g. an HCVF zone identified to mitigate a steep slope's erosion potential, could be modified very slightly to also be beneficial to a rare talus community which may not have qualified for HCVF status on its own).

If the results of a protected areas gap analysis are availabe, these can be used to help guide the selection of areas, but does not necessarily need to be included in the analysis as a value in and of itself.

INTERPRETING THE PRECAUTIONARY PRINCIPLE

Several existing reports have declined to report on overlapping values due to problems with data quality and the potential difficulty in interpreting the analytical results they would produce.

In particular, an assumption made by virtually all analytical methods discussed below is that there is even sampling or coverage or data aross the area of investigation. With the exception of remotely sensed imagery, all data sources suffer this problem to some degree.

Values will often be based largely on "point" occurrence data. These type of data are inherently biased towards transportation corridors, populated places and other access points. This problem of "white holes" in the data can be particularly pronounced in boreal landscapes.

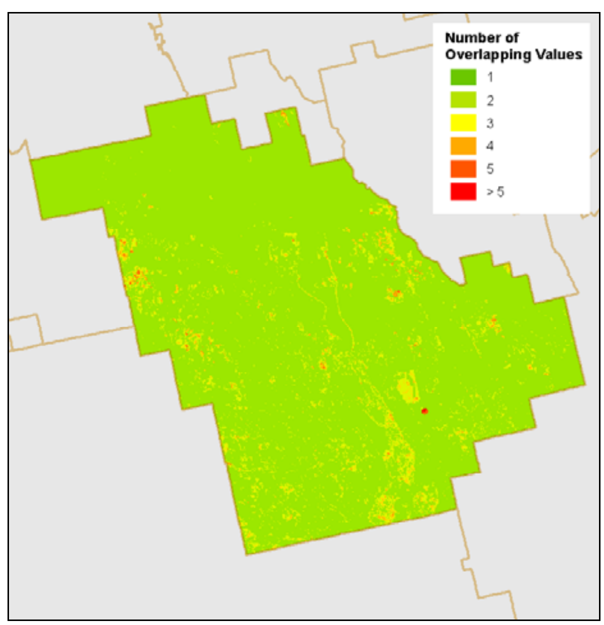
We must acknowledge the shortcomings of the information available, but analyses of overlapping values should not be forgone because of these limitations.

Additionally, it should be remembered that HCVF analyses are iterative processes, and the coincidences of gaps in the data can identify areas for future survey effort.

ADDITIONAL GUIDANCE

Many methodologies have been used to summarize the conservation values present on a landscape and

Figure 19.1 Additive, unweighted overlay of all HCV values using a 150 m resolution grid. Areas of high value overlap tend to be restricted to regions spanning only a few pixels, and are not conducive to identifying HCVF zones.



allocate areas to conservation or special management zones.

Overlay Analyses

Overlays are typically performed as raster-based analyses in which map layers representing each value under consideration are algebraically summed to produce a final surface illustrating the direct spatial intersection of the values. The inputs layers can be weighted to put more importance on values determined to have more significance in the analysis at hand. For example, a layer representing occurences of a G1 ranked species at risk might receive a heavier weighting than an S2 species.

While this method will illustrate the direct areas of overlap, these areas will be dependent on the resolution of the grids (pixel size) of data used and may not represent the zone required to actually address the management of the values identified. Figure 19.1 illustrates an additive, unweighted overlay of hypothetical values on the Spanish Forest. It should be noted that areas of high overlap in this type of assessment are restricted to regions comprised of only a few pixels. This is largely driven by clustered species at risk occurrence data.

Neighbourhood and Density Analyses

Neighbourhood and density analyses summarize multiple layers of data by calculating the number or denisty of values present in a search window of a user-defined size. Theoretically, the size of this search window should be of a scale appropriate to the values being addressed, avoiding the problem of identifying "pixels" of high value, noted above.

The difficulty in implementing neighbourhood and density approaches is the large diversity of values which are simultaneously being addressed. These values are potentially at greatly different scales, both with repect to the spatial extent of the value being measured (e.g. greater than 500,000 ha large landscape level forests, versus species at risk element occurences on the order of tens or hundreds of hectares), and the accuracy with which it has been recorded (e.g. digital elevation models at 30 or 90 metres resolution, forest resource inventory information at 1:10,000 scale, national level datasets at 1:1,000,000 scale). Additionally, the varied topologies of the input data (i.e. points, lines, polygons) can create computational difficulties in assessing a neighbourhood density.

Optimization algorithms

Optimization algorithms are used to find the most efficient solution to achieve a stated set of goals given a stated set of constraints (Williams *et al* 2004). In the context of conservation planning, this usually entails starting with raster-based layers of conservation values (as in an overlay analysis), and selecting the cells which most fully achieve the stated conservation objectives, usually constrained to either the smallest possible area, or allocated based on a cost function. For example, an optimization may have a goal of capturing 30% of the potential habitat for a suite of species in the smallest possible area, or capturing the maximal amount of potential habitat for a suite of species in 5,000 ha.

Some of the more common algorithms used for conservation planning are listed below.

- CPLAN (http://www.ozemail.com.au/~cplan)
- MARXAN (http://www.ecology.uq.edu.au/marxan.htm)
- SITES (http://www.biogeog.ucsb.edu/projects/tnc/overview.html)

While these techniques are powerful tools to summarize information and prioritize lands for conservation planning, at their core, their applicability to HCVF assessments is not as clearly defined. Optimization routines are dependent on setting goals and articulating the constraints under which the goals must be achieved. The intent of HCVF assessments in general, and Question 19 in particular, is to identify those areas which are critical or outstanding, without constraint. That is, if 80% of a forest is found to be of high value, then 80% of the forest should be identified as HCVF. There is no need to balance or optimize the selection of HCVF areas against a set of constraints. More important is the objective setting of thresholds

Table 19.1 Proposed thematic groups of HCV values and thresholds for the number of occurrences which would constitute an HCVF zone under Question 19.

Theme	Inputs	Threshold and Rationale	
Biodiversity	Q1, Q2, Q3, Q4, Q5	≥ 5	High threshold set to avoid bias of clustered sampling of species data
Protected Areas	Q6	≥ 2	Potential provision of connectivity between occurrences
Intact Forest	Q7, Q10	≥ 2	Potential provision of connectivity between occurrences
Ecosystems	Q8, Q9, Q11	≥ 3	Areas of high beta diversity
Basic Services of Nature	Q12, Q13, Q14, Q15	≥ 2	Precautionary approach to the maintenance of ecosystem services
Social Values	Q16, Q17	≥ 3	Areas of multiple use or culturally significant for several reasons
Diversity of Values	Presence or absence of each of the above listed themes	≥ 5	Presence of a substantial diversity of values, recognizing that several values will likely be spatially auto-correlated (e.g. protected areas, intact forests and biodiversity)

against which to assess the values under investigation. If a particular value does not meet the threshold, then there is no need to identify areas as HCVF just to satisfy a quota.

Overlay summarized by ecological units

Much in the same way that neighbourhood analyses summarize the values present within a defined window, we can use pre-existing ecologically defined units in the landscape (e.g. FRI stand polygons, ecosite polygons, etc.) to summarize the results of an overlay analysis. While this method may not accurately represent the scale of certain values being assessed, the use of pre-defined units nonetheless ties the summary of values to ecological communities and processes more than a pixel by pixel derivation of HCVF zones.

Thresholds for concentrations of individual values and for diversity of values

Summarizing values to ecological units is the first step in identifying critical or outstanding areas of overlapping values. To actually delimit HCVF zones for Question 19, thresholds need to be identified and applied to these summarized results.

We propose that a suite of thresholds should be used to identify outstanding areas, considering both the overlaps of numerous values which are thematically similar, and overlaps of different themes. Grouping all data inputs by HCV theme could result in the potential categories and thresholds listed in Table 19.1. In addition to thresholds for overlapping values within a given theme, we also propose threshold for areas that contain a diversity of themes.

Figures 19.2 and 19.3 illustrate the investigation of two of these proposed thresholds, the overlap of biodiversity values, and the diversity of values, respectively. The analyses summarized the overlay of all values by ecosite polygon. It can been seen that, while there are obvious spatial congruencies between these analyses and the unweighted overlay of Figure 19.1, these analyses are able to identify actual units in the landscape that can be considered for HCVF status.

SUMMARY OF RECOMMENDATIONS

- Analysis should incorporate all previously assessed values, both those which met the threshold of HCV and those that did not
- It is recommended that an additive overlay of all values be conducted, summarizing the values using ecological units, such as stand or ecosite polygons
- Multiple thresholds should be identified, both for overlaps of many thematically similar values, and for the diveristy of values present

LITERATURE CITED

Williams, J., C. ReVelle and S. Levin. 2004. Using mathematical optimization models to design nature reserves. Frontiers in Ecology and the Environment 2(2) : 98-105

Figure 19.2 Ecosite polygons shaded according to the number of biodiversity-theme values (as per Table 19.1) which they contain. Using the threshold proposed in Table 19.1, those polygons containing 5 or more values (shaded red) would be designated HCVF.

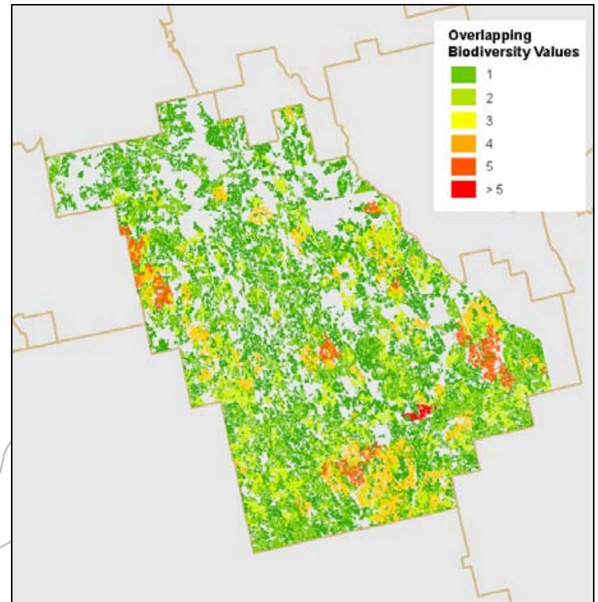
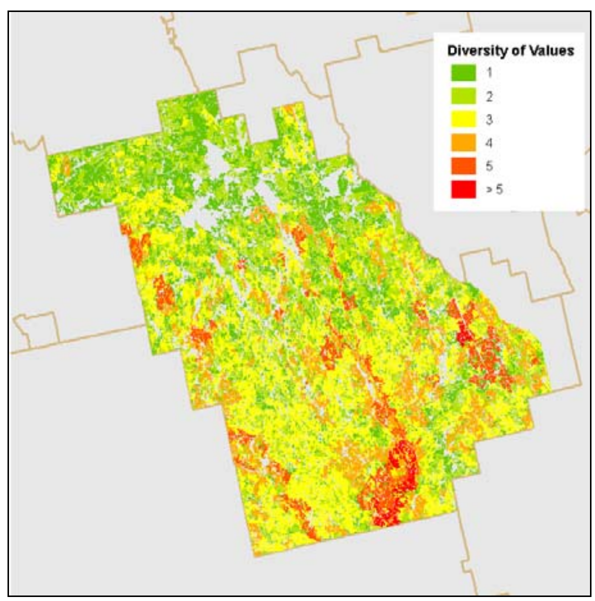


Figure 19.3 Ecosite polygons shaded according to the diversity of HCV themes (as per Table 19.1) which they contain. Using the threshold proposed in Table 19.1, those polygons containing 5 or more values (shaded red) would be designated HCVF.



Q19 – OVERLAPPING VALUES

McCarthy, T., R. Arnup, J. Nieppola, B. Merchant, K. Taylor and W. Parton. 1994. Field guide to forest ecosystems of northeastern Ontario. NEST Field Guide FG-001.

METHODOLOGY

Figures 19.1, 19.2 and 19.3

Data Sources

- WWF-Canada. Designated Areas Database
- CCEA. Canadian Conservation Areas Database (CCAD)
- OMNR. Natural Resource Value layers
    - Regulated Provincial Parks layer
    - Regulated Conservation Reserves layer
    - Crown Game Reserves layer
    - Conservation Authority Lands layer
    - ANSI layer
    - Camps – Recreational layer
    - Deer Yards layer
    - Moose Aquatic Feeding Areas layer
    - Nesting Sites layer
    - Trails layer
    - Wildrice beds layer
- Ontario Natural History Information Centre (NHIC)
    - ANSI-ES Sites
    - ANSI-LS Sites
    - ANSI-LSC Sites
    - Life Sciences (ESA) Sites
    - International Biological Programme (IBP) Sites
    - All Tracked Species and Communities Element Occurrences (1km buffered points)
- Global Forest Watch Canada. Large Remaining Unfragmented Forest Areas (revised). 2001.
- SRTM 90 m Digital Elevation Model. Slope surface derived and reclassified as per the Question 14 guidance using ArcGIS Spatial Analyst 9.
- Forest Resource Inventory polygons.
    - Used in conjuction with tree species range maps from http://climchange.cr.usgs.gov/data/atlas/little to identify occurrences of range edge species.

Methodology

- *N.B.* All input HCVs used for the Spanish Forest are hypothetical and are based on a survey of HCVs identified in the region, but not on any existing HCVF assessment of the Spanish. These are meant for illustrative purposes of this example only.
- Forest Resource Inventory (FRI) polygons were processed using the Ontario Wildlife Habitat Analysis Model (OMNR 2002) software application. This tool allocates FRI polygons to Northeastern Forest Ecosystem Classification site types (as per McCarthy *et al* 1994) using stand attributes.
- Adjacent ecosite polygons were then merged to create polygons of contiguous ecosite type
- All values data was rasterized, using the slope grid as a base.
- These grids were map algebraically summed to produce the unweighted overlay map illustrated in Figure 19.1
- Each individual input data layer was categorized into one of the six themes identified in Table 19.1
- Using the zonal statistics functionality of ArcGIS Spatial Analyst, occurrences of values in each input theme was summarized by ecosite polygon
- Figure 19.2 illustrates the ecosite polygons shaded according to the number of occurrences of "Biodiversity" values (as per Table 19.1) found within it
- Figure 19.3 illustrates the ecosite polygons shaded according to the number of different themes (as per "Diversity" in Table 19.1) found within it