THE INFLUENCE OF FOREST PROPERTY RIGHTS ON FOREST BIODIVERSITY AND ECOSYSTEM HEALTH IN NORTH-EASTERN NEWFOUNDLAND

CHRISTOPHER HOGAN

The Influence of Forest Property Rights on Forest Biodiversity and Ecosystem Health in North-eastern Newfoundland

by

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Abstract

This thesis compares the relative levels of forest health and biodiversity in forests managed by three different property rights holders, within a common ecological region of north-eastern Newfoundland. The objective of the research is to understand the influence of forest property rights on forest health and biodiversity in Newfoundland. Five indicators for forest health and biodiversity, drawn from the Western Newfoundland Model Forest's *Criteria and Indicators of Sustainable Forest Management* (1999), serve as an evaluation framework for the research. Inquiry is carried out through Geographic Information Systems analysis and interviews with forest management experts. Results indicate that factors related to forest property rights such as cutting practices, pressure on the land base, land use changes, and proximity to processing facilities can affect forest health and biodiversity. Differences in forest health and biodiversity manifest when analysis is carried out on a small spatial scale (e.g. a single forest management district) yet tend to "even out" when analysing at a larger spatial scale (e.g. multiple forest management districts).

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List of Abbreviations

ACCC	Abitibi Consolidated Company of Canada Inc.
AND	Anglo-Newfoundland Development Company
AAC	Annual Allowable Cut
bF	Balsam Fir
BtA	Birch-Aspen
bS	Black Spruce
CBPP	Corner Brook Pulp and Paper Ltd.
CCFM	Canadian Council of Forest Ministers
CMF	Canadian Model Forest
CSA	Canadian Standards Association
DI	Disturbed
FSC	Forest Stewardship Council
GIS	Geographic Information Systems
HS	Hardwood-Softwood
IFRI	International Forestry Resources and Institutions
LUCID	Local Unit Criteria and Indicators Development
MFA	Managed Forest Area
MAI	Mean Annual Increment
NFSI	Newfoundland Forest Stand Inventory
NS	Not sufficiently restocked
SFM	Sustainable Forest Management
SH	Softwood-Hardwood
SYM	Sustained Yield Management
TNNP	Terra Nova National Park
TA	Trembling Aspen
wB	White Birch
WNMF	Western Newfoundland Model Forest Inc.

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1 – Introduction

Inquiry into the most appropriate form of property rights over natural resources has been debated in academic and policy arenas for many decades (e.g. Coase 1960, Demsetz 1967, Hardin 1968, Larson and Bromley 1990, Schlager and Ostrom 1992, McKean 2000, and Gibson *et al.* 2002). The debate is focused on which type of property holder (e.g. private owner, state, or local community) can provide the most efficient and socially beneficial stewardship of resources.

Over the past three decades, social values concerning the management and stewardship of natural resources have evolved considerably to include consideration of the long-term maintenance of ecosystem health and biodiversity. This transition has been led by international initiatives such as the United Nations-sponsored Brundtland Commission, which warned that species extinction is occurring at an unprecedented rate and action is needed to conserve the planet's living natural resources (World Commission on Environment and Development 1987). The Brundtland Commission popularized the principles of sustainability and sustainable development, which have become the new standard for socially beneficial resource stewardship. The *Convention on Biological Diversity* (United Nations 1992), signed by 157 nations at Rio de Janeiro in June 1992, including Canada, laid the groundwork for development of national biodiversity conservation strategies.

The new resource management paradigm of sustainable development has been adopted into Canadian forest policy through the *National Forest Strategy* (Canadian Council of Forest Ministers 1992a, 1998a, National Forest Strategy Coalition 2003). The *National Forest Strategy* promotes a new Sustainable Forest Management (SFM) approach, broadly defined as multiple forest value management. SFM includes not only consideration of timber, but also forest biodiversity, ecosystem health, soil and water protection, global impacts, socio-economic objectives, as well as public planning protocols inclusive of aboriginal rights and interests (Canadian Council of Forest Ministers 1992a, 1998a, National Forest Strategy Coalition 2003). Forest policy in Newfoundland and Labrador has evolved in accordance with the national policy shift to also adopt the SFM approach (Government of Newfoundland and Labrador 1996, 2003).

These global, national and provincial policy changes suggest that natural resource property rights systems must also adapt to consider the conservation of biodiversity and ecosystem health. This thesis explores the degree to which the forest property rights system in Newfoundland can accommodate the new demands of biodiversity and ecosystem health protection. It asks, "what is the influence of the current forest property rights system on forest biodiversity and ecosystem health in Newfoundland?"

Researchers of property rights offer competing hypotheses on how property rights influence resource conditions. Demsetz's *Toward a Theory of Property Rights* (1967) and Hardin's *Tragedy of the Commons* (1968) argue that resource degradation is the inevitable tragic outcome of commons resource use. Hardin summarizes the "commons dilemma" as follows: "Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all" (Hardin 1968, 1244). Demsetz (1967) posits that private property ownership is the most efficient and socially optimal system for managing natural resources. A private landowner, "by virtue of his right to exclude others, can generally count on realizing the rewards associated with husbanding the game and increasing the fertility of his land" (Demsetz 1967, 356). Hardin's (1968) analysis echoes that of Demsetz (1967), while also suggesting that management intervention by the state can solve the commons dilemma.

Contemporary researchers study the issue of property rights in the context of the emerging paradigm of sustainable development. These researchers (e.g. Schlager and Ostrom 1992, McKean 2000, and Gibson *et al.* 2002) challenge the dominant theories of property rights (Demsetz 1967 and Hardin 1968) by arguing that no idealized property rights framework can be said to be *a priori* optimal, rather a multitude of economic, environmental, and individual motivation factors will determine resource condition. Schlager and Ostrom (1992) advise that research comparing differing property rights systems in similar environments is required to determine the "best" system.

Researchers who have studied Canada's forest property rights system suggest that tenure holders who have no opportunity to benefit from environmental protection *may* under-provide non-timber values (Pearse 1990, Nelson *et al.* 2003). Others suggest that the only way to maintain biodiversity and ecosystem health is through public intervention and stringent regulations (Haley and Luckert 1992).

This thesis compares relative levels of forest biodiversity and ecosystem health in forests managed by different property rights holders, within a common ecological region. The study area includes forest management districts 4, 5, and 6 in the north-eastern Newfoundland. Forest property rights in the study area are divided between the three main property rights holders on the Island: two pulp and paper companies (Abitibi Consolidated Company of Canada Inc. (ACCC), and Corner Brook Pulp and Paper Ltd. (CBPP), a subsidiary of Kruger Inc.), and the Crown. Five indicators, selected from Criterion One (Forest Biodiversity) and Criterion Two (Forest Health) of *Criteria and Indicators of Sustainable Forest Management: A practical guide to using local level indicators in Newfoundland and Labrador* (Western Newfoundland Model Forest 1999), are used to create an evaluation framework for the research. The five indicators selected are:

1. Area of each forest type by age class;
2. Area of suitable habitat for selected species (including consideration of factors such as connectivity, fragmentation and existence of features such as snags, coarse woody debris, etc);
3. Proportion of each eco-region that is in a protected status;
4. Area and severity of human-caused disturbances (e.g., logging, air pollution, species introduction), and succession pattern afterwards;
5. Frequency, abundance and distribution of selected indicator species relative to natural cycles.

A comparative assessment of each indicator is carried out for each property rights holder within the study area using Geographic Information Systems (GIS) analysis in order to determine if there are measurable differences in forest health and biodiversity. Interviews with forest management experts are undertaken to aid in the interpretation of results.

Drawing on theories proposed by other researchers (e.g. Pearse 1990, Haley and Luckert 1992, Tucker 1999, Gibson *et al.* 2002, Nagrenda 2002, Nelson *et al* 2003), this paper tests three hypotheses concerning the influence of property rights on forest biodiversity and ecosystem health:

Hypothesis 1:

As "companies have no incentive to attempt to produce ... non-timber outputs in a positive fashion" (Nelson *et al* 2003, 243), forest biodiversity and ecosystem health are underprovided on forestlands under tenure of Corner Brook Pulp and Paper and Abitibi Consolidated Company of Canada.

Hypothesis 2:

As the "production of non-timber goods and services can only be ensured through direct public intervention backed up by stringent regulations" (Haley and Luckert 1992), forest biodiversity and ecosystem health are maintained similarly on all forestlands (Crown and company-tenured areas) in Newfoundland, due to a forest management regime based on public participation and strict regulations.

Hypothesis 3:

As "resource outcomes will be determined by the actors, their preferences, and the *de facto* institutions operating on the ground" (Gibson *et al.* 2002), any differences in forest biodiversity and ecosystem health in Corner Brook Pulp and Paper forests, Abitibi Consolidated Company of Canada forests, or Crown forests are not a result of the type of property rights *per se.*

The question of the influence of property rights on forest biodiversity and health is a contemporary topic in Newfoundland. In 2005, the timber license for 207,753 hectares of land held by ACCC expired. In 2010, the company's tenure over 965,565 hectares will expire. CBPP's holdings, covering 2 million hectares, will expire in 2037. As of late 2006, no decisions have been made on the renewal of any of these tenured areas (Newfoundland and Labrador 2003). As deliberations on future forest tenure options commence[1], it is of critical importance that an objective assessment of the management successes and failures of the present tenure system is available to policy makers. Unfortunately, to date, little research has been done on the environmental costs and benefits of current forest property rights arrangements. Munro (1978) researched the emergence of the forest property rights system in the early 20th century Newfoundland and Labrador, but there has been little research carried out on the property rights issue in Newfoundland and Labrador subsequent to the 1992 policy shift to Sustainable Forest Management. Providing input into the debate on forest tenure systems is thus a key objective of this research.

This research paper is divided into the following six chapters:

1. Introduction
2. Research Background: Property Rights and Forest Sustainability in Newfoundland
3. Research Methods
4. Study Area Description
5. Results and Discussion
6. Conclusions

[1] The *Provincial Sustainable Forest Management Strategy* (Government of Newfoundland and Labrador 2003) states that a "working group will be established to investigate future land tenure options for the province" (62).

2 – Research Background: Property Rights and Forest Sustainability in Newfoundland

This thesis aims to understand the influence of forest property rights on forest biodiversity and ecosystem health on the Island of Newfoundland. This chapter provides context to the research by addressing the following questions:

a. What are the main characteristics of forest property rights in Newfoundland?
b. What conclusions have other researchers drawn concerning the influence of property rights on forest biodiversity and ecosystem health?

This chapter concludes by proposing three hypotheses concerning the influence of forest property rights on forest biodiversity and ecosystem health in Newfoundland, which will be tested in the course of this research.

2.1 – Forest property rights in Newfoundland

One of the predominant features of forest property rights in Canada is public ownership combined with private management and use. Regulatory tools such as tenure arrangements have been developed to facilitate the exploitation of timber, and fix the rights and responsibilities of the companies and governments involved (Pearse 1990).

The total land area of the Island of Newfoundland is 11.1 million hectares. Abitibi Consolidated Company of Canada Inc. (ACCC) has tenure over approximately 1.8 million hectares, while Corner Brook Pulp and Paper Ltd. (CBPP), a subsidiary of Kruger Inc., maintains tenure over approximately 2.0 million hectares. A little less than half of the Island, 5.1 million hectares is forested, with 3.0 million hectares (59%) classified as "productive forest"[2], and the remainder as "non-productive", from a commercial perspective. Of the 3.0 million hectares of productive forest, 1.77 million hectares (59%) falls within company tenured lands, with CBPP controlling 32.7% and ACCC controlling 25.7%. The balance of productive forest land is primarily "unalienated Crown land" (39%), with the remaining (2.6%) held in national parks, reserves, or small private holdings (see Table 1) (Government of Newfoundland and Labrador 2003).

Productive forest under company tenure is composed of a mixture of freehold, leased and licensed land. Licensed land makes up the majority of the ACCC and CBPP holdings and grants the companies timber rights for a 99-year period. All of ACCC's licenses have been consolidated to expire in 2010, while CBPP's licenses expire in 2037. Both companies also hold areas of private land, classified as freehold land. Anglo-Newfoundland Development (AND) Company and Bowaters Ltd., predecessors of ACCC and CBPP respectively[3], acquired these lots from the Reid Newfoundland Company. The Reid Newfoundland Company had been granted 1,035,218 hectares of freehold land across the Island as part of its payment for the construction of a railway. Finally, ACCC also has significant holdings of leased land. The leased land was acquired by AND Company from the government and grants water, mineral and timber rights (Munro 1978). There are three types of leases: 99-

[2] The *Forestry Act* (1990) states that Productive Forest is "an area of forest land producing or capable of producing, at rotation age and under natural conditions, a forest stand containing a minimum merchantable timber volume of 30 m^3 (solid) per hectare".

[3] ACCC tenured lands were originally under tenure of the Anglo-Newfoundland Development (AND) Company. In 1965 the AND Company joined with the Price Company to become Price Pulp and Paper. In 1979 the company became Abitibi-Price. Abitibi-Price and Stone-Consolidated merged in 1997 to form Abitibi-Consolidated Company of Canada. The CBPP mill was incorporated in 1927 as the International Paper Company of Newfoundland Limited and was acquired by Bowater Corporation in 1938. In 1984 the CBPP mill was purchased by Kruger Inc. (Newfoundland and Labrador Forest Protection Association, n.d.).

year leases, 999-year leases, and automatically renewable 99-year leases (also called chartered land) (Abitibi Consolidated Company of Canada 2001).

Table 1: Area of productive forest by tenure type and tenure holder (Source: Government of Newfoundland and Labrador 2003).

Tenure	Area of productive forest (hectares)	Percent (%) of total productive forest area
By Tenure Type		
Leased	123,400	4.1
Licensed	1,579,900	52.0
Individual Freehold	69,700	2.3
Crown	1,185,300	39.0
Other	77,800	2.6
Total	**3,036,000**	**100**
By Tenure Holder		
Corner Brook Pulp and Paper	992,600	32.7
Abitibi Consolidated Company of Canada	786,400	25.7
Crown	1,185,300	39.0
Other (National Parks, Private land, other reserves)	77,800	2.6
Total	**3,036,000**	**100**

The geographic pattern of forest property rights found today on the Island (see Figure 1) is the result of what Munro (1978) calls a "concentration process" which played out in the Newfoundland pulp and paper sector in the early 20th century. In the early 1900s, six mills were established and efforts were made to establish four others. But as the majority of these ventures failed, most of the timber licenses and valuable Reid Newfoundland Company holdings were acquired by the operators of the two successful mills at Grand-Falls (AND Company) and Corner Brook (Bowaters Ltd.). In general, the paper companies' holdings are located in the more productive interior forest lands, while Crown-controlled forests are distributed around the less-productive coastal areas where more domestic cutting occurs (see Figure 2) (Government of Newfoundland and Labrador 2003).

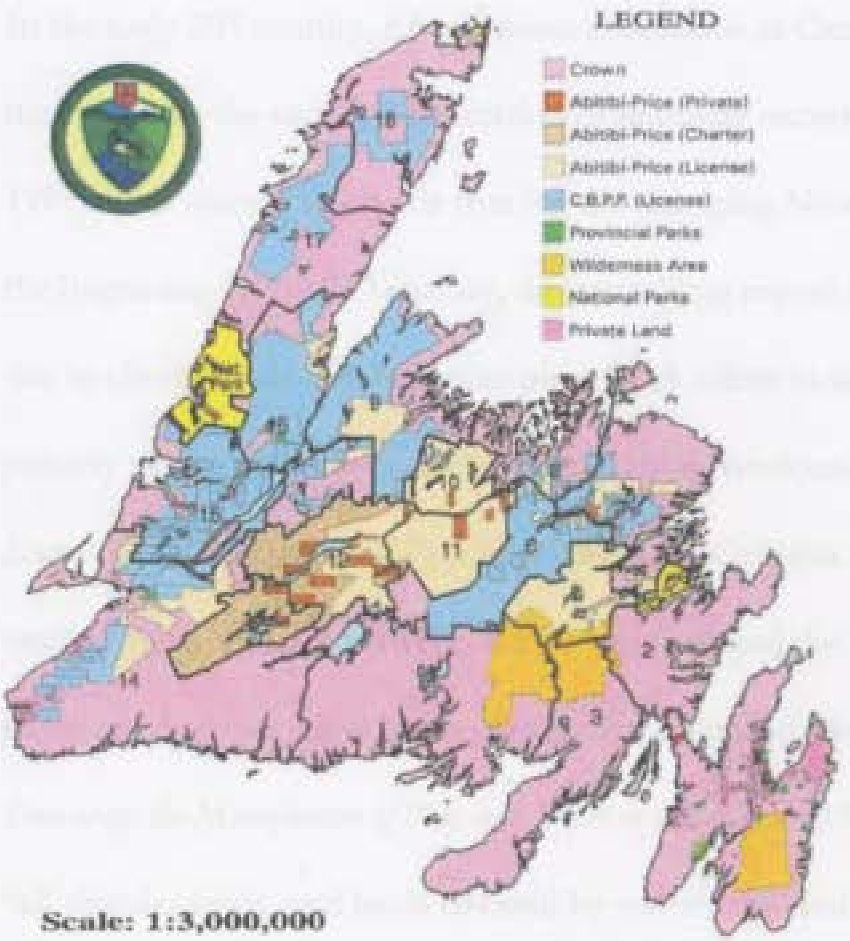

Figure 1: Newfoundland forest tenure distribution and management districts
(Source: Government of Newfoundland and Labrador: http://www.nr.gov.nl.ca/forestry/maps/nf_timber.stm)

Figure 2: Productive forest landbase, Newfoundland
(Source: Government of Newfoundland and Labrador: http://www.nr.gov.nl.ca/forestry/maps/prod_timber.stm)

In the early 20th century, forest tenure allocations in Canada were designed to attract capital necessary for the orderly exploitation of naturally occurring mature timber stands (Luckert 1997). This assessment holds true for the emerging Newfoundland pulp and paper sector. At the beginning of the 20th century, the sawmilling export industry was already beginning to fail due to shortages of suitable white pine. In an effort to tackle high unemployment and poverty through economic diversification, the Newfoundland legislature passed *An Act to Encourage the Manufacture of Pulp and Paper in this Colony* in 1905 (Munro 1978). This legislation ratified the agreement between the government and the AND Company, including the issuance of timber leases in the Red Indian Lake and Victoria Lake region. The *Act to Encourage the Manufacture of Pulp and Paper in this Colony* (1905) leased to the AND Company "all singular lands, and lands covered by water… all timber and trees being on the said lands, and also all mines and minerals therein and thereunder … for the term of ninety-nine years." The act granted the lessee exclusive right to occupy the land for logging, mining activity, and for damming or diverting water courses for logging operations. But it did not grant the lessee exclusive right to occupy the land. The public right of access for fishing and hunting was preserved (Munro 1978).

In 1938, a second key piece of legislation was passed, the *Bowater's Newfoundland Act*, consolidating all timber licenses associated with the Corner Brook mill to a common expiry date of 2037. This act "vest[s] in the holder thereof all right of property whatsoever in all trees and timber cut within the limit of the license…". It also stipulates the "Company will at all times carry out its cutting operations in Newfoundland in accordance with good logging practice in such a manner as will best conserve the Company's forest areas so as to ensure both the permanent supply of timber for its mills and extensions aforesaid and the export of timber as herein provided."

Pearse (1988, 1990) notes that there can be significant variation in forest tenure arrangements, ranging in comprehensiveness, duration, benefits conferred, transferability and exclusiveness. Depending on the degree of comprehensiveness, duration, etc., property rights range from comprehensive freehold to non-exclusive common property rights, and tend to be paralleled by an increasing dependence on government to manage the resources and regulate use (Pearse 1988, 1990). Differences can be noted in the three tenure types in Newfoundland: freehold, leased lands, and licensed lands. Leases such as those issued under the *Act to Encourage the Manufacture of Pulp and Paper in this Colony* (1905) tend to closely resemble private ownership in that they provide exclusive use and benefits over resources, essentially in perpetuity (Munro 1978). Licences tend to confer fewer benefits (i.e. they exclude mineral rights), though they are set for very long durations of 99 years. According to the report *The State of Canada's Forests 2003-2004*, the "Province's financial and legal system treats [all tenured] land as private property" (Government of Canada 2004, 27).

Not surprisingly, the statutes of 1905 and 1938 make no stipulations regarding the conservation of forest biodiversity and ecosystem health as a condition of the licenses or leases. Such late-twentieth century management objectives are dealt with through other regulatory measures. In fact, over the course of the 20th century, a myriad of regulatory measures have evolved to provide checks and balances to industrial forest development. Irrespective of tenure type or tenure holder, therefore, forestlands in Newfoundland are subject to environmental protection through federal statutes like the *Fisheries Act (2004)* and

Species at Risk Act (2002), as well as provincial statutes addressing forests (*Forestry Act 1990*), environmental assessment (*Environmental Protection Act 2002*), and endangered species (*Endangered Species Act 2001*).

The tenure statutes and grants in combination with the above-mentioned legislation compose a regulatory regime which both facilitates and constrains the exercise of forest property rights. Companies holding tenure over public land or freehold lands are constrained in their operations by regulatory guidelines such as annual allowable cut rates, appurtenance requirements, specific logging practices, environmental protection measures, etc.. All regulatory measures are periodically re-evaluated to ensure they reflect society's demands on forest management and use. According to the province's *Forestry Act* (1990), any new tenure allocations over large forest areas will be of 20-year duration, thus reflecting society's interest to have stronger control over forest management.

2.2 – The potential influence of property rights on forest health and biodiversity

Over the course of the 1990s, national forest policy began to shift from Sustained Yield Management (SYM) towards ecosystem-based Sustainable Forest Management (SFM). As a body of inter-provincial forestry ministers, the Canadian Council of Forest Ministers (CCFM) confirmed its commitment to SFM in its 1992 *National Forest Strategy.* This document proposed a set of SFM principles including maintenance of ecological health and wildlife species, recognition of multiple forest values, involvement of the public in forest planning, maintenance of viable and stable forest-based communities, and recognition of aboriginal peoples' rights in forest management (CCFM 1992a). The commitment to SFM has been reconfirmed and elaborated through revisions to the *National Forest Strategy* (CCFM

1998a, National Forest Strategy Coalition 2003), as well as through the *Canada Forest Accord* (CCFM 1992b, 1998b, 2003b). The latter, endorsed by government agencies, and representatives of the forest products industry and environmental organisations, provides a similar approach to defining SFM as the maintenance or enhancement of the ecological, social, and economic components of forested areas. Collectively, these policy statements form the foundation for SFM in Canada, and are broadly agreed upon by most participants in forest policy debates in Canada (Adamowicz and Burton 2003).

The transition from SYM to SFM in Newfoundland and Labrador began in the early 1990s, and has been officially endorsed and articulated through 1996 and 2003 provincial forest policy documents. The *20 Year Forestry Development Plan 1996-2015* (Government of Newfoundland and Labrador 1996) and the *Provincial Sustainable Forest Management Strategy 2003* (Government of Newfoundland and Labrador 2003) detail the province's position on SFM, which is essentially adopted from the 1992, 1998 and 2003 *National Forest Strategy.* The Forest Service of Newfoundland and Labrador offers the following vision for the province's forests:

> *The forests of Newfoundland and Labrador will maintain a sustainable balance of environmental, economic, and cultural values desired by society. They will provide for viable populations of native species, sustainable yields of forest products and the creation of wealth and employment to support local, regional and provincial economies* (Government of Newfoundland and Labrador 2003, 7).

SFM is described as evolving from the SYM system, while incorporating many of its management principles (Ross 1995, Howlett and Rayner 2001, Adamowicz and Burton 2003). Though biodiversity and ecosystem health concerns are given attention under SFM, it has not meant that timber values have been left by the wayside. On the contrary, the "liquidation-conversion" approach[4] of sustained yield forestry remains a component of SFM[5]. In managing for sustained yield of timber, a manager carries out spatial planning to determine the perpetual supply of wood to be expected. As Adamowicz and Burton (2003) explain, "This step remains a cornerstone of forest management as it extends the pioneering concept of sustained yield to other forest values" (53). SFM broadens forestry practices to sustain yields of an array of forest attributes, not just timber. It shifts emphasis in forest management to a "more holistic, ecologically oriented approach that takes into account the full range of forest values" (CCFM 1992a, 18).

Several researchers (Pearse 1988, 1990, Haley and Luckert 1992, Luckert 1995, Ross 1995, Adamowicz *et al.* 2003, and Nelson *et al.* 2003) note that forest tenure systems in Canada have generally not been designed to meet the demands of the newly emerging SFM paradigm. In similarity to the experience in Newfoundland, provincial forest policies in Canada evolved in an era when timber was *the* important commercial forest product and the mature forest inventory was regarded as an inexhaustible resource. Tenure frameworks were designed primarily to attract capital necessary for the orderly exploitation of those forests and create employment. Haley and Luckert (1992) conclude that, "current tenure arrangements are inadequate, in several ways, to handle these new developments."

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[4] Howlett and Rayner (2001) describe Sustained Yield Management (SYM) as a regime of "liquidation and conversion". The SYM approach is designed to "facilitate and speed the process of converting natural forests to tree farms, or plantations, which could sustain the long-term fibre needs of industry" (Howlett and Rayner 2001, 27).

[5] For example, the CCFM's 2003 Criteria and Indicators for SFM includes Core Indicator 5.3.1: "Annual harvest of timber relative to the level of harvest deemed to be sustainable" (CCFM 2003a, 16).

A weakness of forest tenure schemes noted by researchers is that though tenure holders have exclusive rights to log timber, they usually have no opportunity to benefit from non-timber forest products, and therefore have little incentive to sustain them (Pearse 1988, 1990; Haley and Luckert 1992, Adamowicz *et al.* 2003, Nelson *et al.* 2003). As Pearse (1990) explains:

> *If someone holds the rights to the timber in a forest, but not to the water, wildlife, or other benefits which are affected by his timber operations, and if he does not need to compensate anyone for any adverse effects on these other values, he will tend to ignore them. In these circumstances, the holder will seek to maximize the benefits which he can claim, disregarding those which he cannot claim and any external costs or benefits he may inflict on others* (178).

Or, as stated by Nelson *et al.* (2003):

> *Economic theory suggests that positive externalities associated with forests, and public goods such as wildlife, clean water, and carbon sequestration, will be underprovided if we rely on the private sector to supply such goods. Non-timber values are a constraint in the planning process from the company's point of view if it is the one preparing the plan. Companies have no incentive to attempt to produce these non-timber outputs in a positive fashion and, given a choice, may not choose plans that offer substantial improvements in environmental benefits. Put another way, non-timber objectives become residual values to the harvesting decisions, given the imposition of external constraints to meet these objectives (243).*

Haley and Luckert (1992) argue that in the absence of incentives for multiple product management, the "production of non-timber goods and services can only be ensured through direct public intervention backed up by stringent regulations." Nelson *et al.* (2003) suggest that where externalities and public goods are national or international in scope (such as biodiversity or carbon sequestration), there is no reason to expect provincial governments will provide the right mix of goods. "Stringent regulations" are part of the forest regime in Newfoundland and Labrador (e.g. *Forestry Act 1990, Endangered Species Act 2001, Fisheries Act 2004, Environmental Protection Act 2002, etc.)*, and are in theory applied equally, regardless of tenure holder or tenure type.

Drawing on the commentary presented by Pearse 1990, Haley and Luckert 1992, and Nelson *et al.* 2003, one could describe the forest regime in Newfoundland and Labrador as having significant internal tension. Tenure holders who cannot benefit from conservation of biodiversity and forest health may have little incentive to protect such values, and may under-provide them in a quest to maximize the value of their timber rights; in opposition, governing agencies responsible for protection of forest health and biodiversity attempt to constrain the exercise of timber property rights where environmental values may be compromised by applying regulatory measures. This internal tension is perhaps fully expressed on Crown forests, where the province must apply environmental regulatory measures on its own forest management plans.

The (ongoing) transition from SYM to SFM illustrates that there is certainly tension inherent in the Canadian forestry regime. There is general agreement with the broadly defined Criteria and Indicators for SFM (CCFM 1995, 1997, 2000, 2003a), but competing actors have challenged attempts to set provincial- and management district-scale targets and thresholds for the Criteria and Indicators. As Ross (1995) explains, "even though all concur that minimum standards must be established, disagreements arise about the required level of specificity and constraint, the level of ecosystem "health" to be maintained, and the way in which this "health" may be best achieved" (318). No provincial- or district-scale targets for SFM have been successfully defined for Newfoundland and Labrador. This means that agreement has not been reached on the level to which non-timber forest products will be sustained over time. Nevertheless, timber continues to be managed in Newfoundland by maintaining a continuous stock determined by the annual allowable cut calculation for each tenure holder in each forest management district. But as Luckert and Williamson (2005) state, "part of the reason for shifting from SYM towards SFM comes from recognizing that perpetuating timber does not necessarily perpetuate non-timber values." The SYM approach has the potential to alter forest structure across the landscape such that biodiversity is ultimately reduced by reforestation to commercial species, and creation of a regulated forest with a trend towards younger age-classes (Luckert and Williamson 2005).

Tenure holders who tend to employ a SYM approach as opposed to the SFM approach, may therefore produce negative outcomes for forest biodiversity and health. This suggests that the type of tenure (e.g. company-tenured land, community-tenured land, or Crown land) does not, *per se*, determine the level of forest biodiversity and health. Rather, the management approach employed by the tenure holder may be of more significance.

This view of property rights is supported by a group of researchers specializing in common-property rights theory and community-based management. Research on sustainability outcomes for community-based management emphasizes the importance of decision-making institutions (Ostrom 1990, Baland and Platteau 1996, Arnold 1998, Agrawal and Gibson 1999 and McKean 2000). Decision-making institutions are the primary mechanisms through which to shape and facilitate particular management actions and outcomes. They are the formal rules (e.g. *de jure* property rights) and informal rules (e.g. *de facto* property rights) which shape interactions of humans with others and nature (Agrawal and Gibson 1999). Research that incorporates an analysis of decision-making institutions recognizes that localized property holders make decisions about resources within a broad social, political and economic context. It also emphasizes the importance of recognizing that a property holder (individual, state, or community) seeks fulfillment of its own interests, which can shift as new opportunities emerge (Gibson *et al.* 2002).

Though a body of theoretical research exists on the relative merits of common property rights versus other property rights systems, Tucker (1999) notes that few empirical studies have been carried out which have "compared the ecological and social outcomes of these different property arrangements within a single ecosystem and socio-political context." A literature search for empirical research that fits the above description produced three relevant studies: from Honduras (Tucker 1999), Guatemala (Gibson *et al.* 2002), and Nepal (Nagrenda 2002). The Honduran and Guatemalan papers conclude that the form of tenure is not a good predictor of sustainable management. Instead, the more critical factors as Tucker (1999) explains, "are whether the owner(s) have decided to limit their levels of exploitation, and are able to achieve their goals through monitoring and enforcement. As Gibson *et al.* (2002) explain, "There is no reason to believe that a forest policy based on the establishment of either formal private or common property rights leads to good forest management. Instead, resource outcomes will be determined by the actors, their preferences, and the *de facto* institutions operating on the ground." Nagrenda (2002) identifies differences in forest condition in the community forests, state forests, and national park forests surveyed, but concludes that further research is needed over a longer time frame to better understand the 'success' of the community forest initiative.

Ultimately, the real test of any property rights scheme will be measured by its ability to sustain in perpetuity the natural systems it aims to protect. Schlager and Ostrom (1992) recommend comparative research to determine how various types of institutions perform in similarly difficult environments. "No real-world institution can win in a contest against idealized institutions", state Schlager and Ostrom (1992).

2.3 – Conclusions: identifying the research hypotheses

Forest property rights in Newfoundland are shared between the Crown and two pulp and paper companies. Property-rights held by the companies are of three types: freehold, lease, and license. Though only the freehold lands are truly private property, the leases and licenses held by the companies are of 99-year duration (and in some cases renewable), and therefore resemble freehold grants. The exercise of property rights is constrained however by a broad suite of regulatory measures.

Over the past two decades, the forest management paradigm in Newfoundland has begun to shift from Sustained Yield Management to Sustainable Forest Management. This means that forest property rights owners are now not only responsible for providing a sustainable flow of timber to mills, but, simultaneously, are also now tasked with sustaining certain levels of forest biodiversity and health over time on their lands. Forest tenure arrangements have been designed to facilitate timber extraction, and as such were in tune with Sustained Yield Management objectives. It is now important to examine how the Newfoundland forest property rights framework is faring under the newly emerging Sustainable Forest Management paradigm, particularly in its ability to sustain forest biodiversity and health.

In order to determine the relative influence of property rights on forest biodiversity and health in Newfoundland, comparative research is required. The above discussion first indicates that tenure holders who have no opportunity to benefit from environmental protection *may* under-provide non-timber products. In contrast, other researchers posit that no idealized property rights framework can be said to be *a priori* optimal, rather a multitude of economic, environmental, and individual motivation factors will determine resource condition. Researchers also suggest that a property rights holders' management approach (e.g. Sustained Yield Management or Sustainable Forest Management) is also critical to determining resource condition. Property rights holders who employ Sustained Yield Management as opposed to a Sustainable Forest Management approach, may alter forest structure within their defined forest area by altering tree species composition towards more commercial species, and lowering the natural age-class distribution of trees.

By way of interviews with forest management experts as well as Geographic Information Systems (GIS) analysis, this research aims to determine whether or not there are measurable differences in forest biodiversity and ecosystem health on CBBP, ACCC, and Crown forests within the study area. Using the results of the interviews and GIS analysis, the research will test the following three hypotheses (in no order of preference):

Hypothesis 1:

As "companies have no incentive to attempt to produce ... non-timber outputs in a positive fashion" (Nelson *et al.* 2003, 243), forest biodiversity and ecosystem health are underprovided on forestlands under tenure of Corner Brook Pulp and Paper and Abitibi Consolidated Company of Canada.

Hypothesis 2:

As the "production of non-timber goods and services can only be ensured through direct public intervention backed up by stringent regulations" (Haley and Luckert 1992), forest biodiversity and ecosystem health are maintained similarly on all forestlands (Crown and company-tenured areas) in Newfoundland, due to a forest management regime based on public participation and strict regulations.

Hypothesis 3:

As "resource outcomes will be determined by the actors, their preferences, and the *de facto* institutions operating on the ground" (Gibson *et al.* 2002), any differences in forest biodiversity and ecosystem health in Corner Brook Pulp and Paper forests, Abitibi Consolidated Company of Canada forests, or Crown forests are not a result of the type of property rights *per se.*

3 – Research Methods

This chapter outlines the research methods used to assess the influence of forest property rights on forest health and biodiversity in the study area.

3.1 – Background

The research methods employed in this thesis draw on approaches from three initiatives: the International Forestry Resources and Institutions (IFRI) Research Program (Ostrom 1998), the United States Forest Service's Local Unit Criteria and Indicators Development (LUCID) Test (Wright 2002), and the Canadian Model Forest's (CMF) Local Level Indicators of Sustainable Forest Management (Canada's Model Forest Program 2000).

Though all three initiatives are engaged in research and monitoring of forest sustainability, the only initiative that has been used to empirically test the influence of forest property rights on forest conditions is the IFRI method. A literature search produced relevant IFRI case studies from Honduras (Tucker 1999), Guatemala (Gibson *et al.* 2002), and Nepal (Nagendra 2002). In each of these studies, the researcher established study plots in areas of similar forest type, but different tenure type. All three studies combine quantitative measures of forest condition with information on the institutional, demographic and economic characteristics of the site. Measures to assess forest condition include tree and sapling basal area, tree and sapling density, and tree species richness. The forest conditions in study plots of different tenure type are compared by employing statistical analysis (e.g. Independent *T*-Tests (Tucker 1999, Gibson *et al.* 2002), Mann-Whitney test (Tucker 1999, Nagendra 2002), and regression analysis (Gibson *et al.* 2002)), through interviews with local forest users (Tucker 1999, Nagendra 2002), interviews with forest owners and local government officials

(Tucker 1999, Gibson *et al.* 2002), and through surveys of the study plots by a professional forester (Nagendra 2002).

The method used by Tucker (1999), Gibson *et al.* (2002), and Nagendra (2002) (hereafter referred to as the "IFRI method") to assess the influence of forest property rights on forest conditions can be summarized by the following steps:

1. A study site is selected which is composed of differing tenure types, but similar ecological conditions;
2. The ecological, institutional, demographic and economic character of the study site is described;
3. Forest conditions are assessed in the study plots of differing tenure type using a standard set of measures (tree density, basal area, species richness);
4. Statistical analysis is used to determine if there are significant differences in forest conditions between the study plots;
5. Interpretation of the differences in forest condition between tenure types is aided by ecological, institutional, demographic and economic analysis.

The IFRI method has been used to assess the influence of tenure on 'forest condition,' as opposed to 'forest health and biodiversity,' and has been applied in Nepal, Honduras and Guatemala respectively. Though a good starting point for developing a methodology for this thesis, the potential application of the IFRI method in a Newfoundland context raises a series of questions. How should forest health and biodiversity be defined for Newfoundland forests? Secondly, what types of measures are appropriate for an assessment of forest health and biodiversity in Newfoundland? And finally, what types of analysis and interpretation techniques are needed to assess the influence of forest tenure on forest health and biodiversity in Newfoundland?

3.1.1 – Local indicators for forest health and biodiversity

Much of the discussion surrounding the definition and monitoring of forest ecosystem health and biodiversity in Canada has occurred in the context of various criteria and indicator frameworks[6] for Sustainable Forest Management (SFM) (e.g. Canadian Council of Forest Ministers (CCFM) 1995, 1997, 2000, 2003a, Canadian Standards Association (CSA) 2002, and Forest Stewardship Council (FSC) 2004). The CCFM, CSA, and FSC indicator initiatives have served to define the elements of SFM on a national scale. In an evaluation of three forest sustainability criteria and indicator systems, including the CCFM set, Woodley *et al.* (1998) conclude that if forest monitoring is to successfully inform management action at the forest management unit scale, monitoring activities must be tailored to that same scale. Wright's (2002) report on the United States Forest Service's Local Unit Criteria and Indicators Development (LUCID) Test[7] also supports the use of a locally derived set of criteria and indicators for forest sustainability assessments. As Wright (2002) explains, forest sustainability, and each of its components (ecological sustainability, economic sustainability, and social sustainability) are inherently value-based definitions. As such, forest sustainability will mean many different things to different people, depending on their perspective. A definition of local ecological sustainability must therefore reflect a range of local interests. In order to address the range of possible perspectives on what sustainability is, Wright (2002) recommends an interdisciplinary and collaborative approach to all stages of a forest sustainability assessment, including the selection of indicators, selection of reference values for indicators, determination of measurement techniques, and finally, interpretation of the

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[6] Criteria and indicator frameworks are designed to help provide a common understanding of what is meant by sustainable management and to frame the monitoring process (Wright 2002).

[7] The LUCID Test was a pilot project that established a framework to monitor and assess forest sustainability using a criteria and indicators approach in six US National Forests.

findings. She contends that "collaboration can play an important role in the sustainability assessment process because it can more efficiently: serve as a basis for dialogue; identify all key components for monitoring; set reference values; access alternative sources of data; and expedite reporting and communicating of sustainability assessment results" (70).

With its interest in developing monitoring programs that might contribute to management decisions which occur at a forest management unit or local level, and recognizing the variance in ecological, social and economic conditions across Canada, the Canadian Model Forest (CMF) program initiated a Local Level Indicators program for SFM. The CMF Local Level Indicators program has produced locally vetted, distinct sets of criteria and indicators for SFM for each model forest in the country (CMF 2000). In Newfoundland, the Western Newfoundland Model Forest (WNMF) published *Criteria and Indicators of Sustainable Forest Management: A practical guide to using local level indicators in Newfoundland and Labrador* in 1999. These criteria and indicators were developed through a multi-stakeholder based, collaborative process (which included representation from CBPP, ACCC, and the Crown) in the late 1990s, and include six criteria: forest biodiversity, ecosystem health, soil and water, global impacts, socio-economic objectives, and public planning protocols acknowledging aboriginal rights and interests.

For the purposes of this thesis, WNMF's *Criteria and Indicators of Sustainable Forest Management* (1999) provides a framework for understanding the concepts of forest biodiversity and forest health (see Appendix 1). Biodiversity refers to "the variety of organisms that are found within our forest", while forest health is defined by factors such as incidence of disturbance and stress, ecosystem resilience, and productivity (WNMF 1999). *Criteria and Indicators of*

Sustainable Forest Management (WNMF 1999) includes a total of 16 indicators which can be used to measure and monitor forest biodiversity and forest health. Employing Wright's (2002) interpretation of forest sustainability, it must be understood that the set of indicators offered for forest biodiversity and forest health by the WNMF (1999) is value-based. Likewise, the interpretation of indicator measures is also value-based, and will vary according to one's perspective. A healthy forest may therefore be defined by some as a "natural" forest, characterized by large-scale disturbance events and a high proportion of old-growth stands. Yet, others may define a healthy forest as one composed of evenly distributed forest age classes, untouched by natural disturbance, and capable of producing a continuous flow of forest products year after year.

The reader should also be aware of the influence of forest biodiversity on forest health, and vice-versa. An increase in forest biodiversity, for example, may not necessarily benefit the overall health of a forest. Newfoundland forests have seen an increase in biodiversity with the introduction of non-native species such as the Moose, Snowshoe Hare and the Red Squirrel. Browsing by these species has negatively affected the natural regeneration of several conifer and hardwood species (Power 2000). One could therefore argue that in the case of these three species, an increase in biodiversity in Newfoundland forests has negatively impacted forest health. Others may argue however that the presence of Moose, Snowshoe Hare and Red Squirrel is a sign of a healthy forest. Acknowledging that forest biodiversity and forest health are normative, value-based concepts, it is clear that their measurement must incorporate a variety of viewpoints.

3.1.2 – Measuring and interpreting local indicators

Wright (2002) points out that though the concept of criteria and indicator monitoring has been around a long time, "the development of sustainability monitoring at the forest management unit level is still in its infancy" (51).

The *State of the Forest Report for the Western Newfoundland Model Forest* (WNMF 2000) is the only forest sustainability assessment that has been carried out in Newfoundland, and provides direction on the selection, measurement and interpretation of indicators. The assessment was carried out on the Western Newfoundland Model Forest area (covering three forest management districts and Gros Morne National Park) and employed the WNMF (1999) criteria and indicator set as a basis for the assessment. The general approach to data gathering, measurement, and interpretation was collaborative, drawing on the staff expertise and data from the Provincial Forest Service, Provincial Wildlife Division, Gros Morne National Park, and the pulp and paper companies located within the model forest region. The WNMF indicators lack thresholds or targets. Therefore measures in the *State of the Forest Report* portray trends in data (e.g. Population levels of caribou over a three year interval, and changes in area of insect, fire and logging disturbance over an eleven year interval). Reference values are not defined in the report, though the concept is incorporated in the interpretation of some indicators (e.g. "In general, the figures are within a broad range of what forest ecologists might consider "normal" for this ecosystem") (WNMF 2000, 15).

Establishing reference values is a key component of sustainability monitoring (Woodley *et al.* 1998, Wright 2002, Adamowicz and Burton 2003). Measures are made to reveal the state of an indicator in comparison to a specific reference value. As Wright (2002) explains,

"...reference values represent desired future conditions about the state of the systems that are to be sustained" (74). Most criteria and indicator initiatives however lack reference values, and compare indicators against trend data (Wright 2002). Adamowicz and Burton (2003) note that the "natural disturbance model", which endorses the emulation of natural processes and patterns as guidelines for the conservation of biodiversity, provides one approach to setting baseline references in forest sustainability monitoring. Wright (2002) recommends that reference values be determined through a collaborative process as various reference values could be in conflict with one another. Resolution of such conflicts may necessitate discussion amongst different stakeholders. Whatever reference values are selected in a forest sustainability assessment, their "rationale, assumptions, and data used to develop reference values should be well documented" (Wright 2002, 163-164).

Wright (2002) suggests that the interpretation of indicator measures should predominantly be "narrative in nature", drawing on the perspectives of multiple stakeholders. As she explains, "Narrative approaches provide rich description of detail and can help synthesize across system components, reveal emergent properties, and facilitate the discussion of results across spatial scales" (x, Wright 2002). As noted above, researchers employing the IFRI method undertook qualitative interviews to assist with interpretation of quantitative data (Tucker 1999, Gibson *et al.* 2002, Nagendra 2002).

3.2 – Methodology

This thesis follows the general methodological approach of Tucker (1999), Gibson *et al.* (2002), and Nagendra (2002). A study area of similar ecological type, but of differing tenure holders is selected, and its ecological, institutional, and demographic character is described.

Measures of forest health and biodiversity are made (as opposed to forest condition), using selected indicators from *Criteria and Indicators of Sustainable Forest Management: A practical guide to using local level indicators in Newfoundland and Labrador* (WNMF 1999)[8]. In order to carry out the research in a timely manner, five of the 16 indicators from Criterion One (Forest Biodiversity) and Criterion Two (Forest Health) from WNMF (1999) were selected for measurement. The selection of five indicators was carried out through scoping interviews (both face-to-face and telephone) with nine forest management experts from various perspectives – three Crown forest managers, one Crown forest ecologist, two pulp and paper sector representatives, one academic forest management expert, one academic forest ecologist, and one non-governmental environmental organisation representative. Memorial University of Newfoundland's Interdisciplinary Committee on Ethics in Human Research reviewed and approved the proposed interview process. All materials provided to the interview subjects, including background information and questionnaire, are in Appendix 1.

Measurements of the five selected indicators were carried out through Geographic Information Systems (GIS) analysis, and where possible, employed methods used in the *State of the Forest Report for the Western Newfoundland Model Forest* (WNMF 2000), and also draw on methods used in the CBBP and ACCC SFM plans for Canadian Standards Association SFM Z-809 certification (ACCC 2001, CBPP 2004). The primary data source used to carry out the assessment is the Newfoundland Forest Stand Inventory data, provided to the researcher by

[8] In seeking Canadian Standards Association SFM Z-809 certification, both CBPP and ACCC have developed unique sets of criteria and indicators for SFM for their respective tenure areas in Newfoundland (ACCC 2001, CBPP 2004). The CBPP and ACCC sets of criteria and indicators are linked with the CCFM sets (e.g. CCFM 2000). The WNMF set of criteria and indicators is selected for use in this thesis as it is the only set which was developed with the participation of the three tenure holders which are under focus in this thesis (CBPP, ACCC, and the Crown).

the Department of Natural Resources (Forestry Branch). Data on habitat suitability for the Newfoundland Marten and range and abundance of Woodland Caribou were supplied by the Department of Environment and Conservation (Wildlife Division).

Selection of reference values and interpretation of the indicator measures for each tenure area were aided by a second round of interviews with five (of the original nine) interviewees representing differing perspectives, who were most familiar with the study area.

3.3 – Issues of spatial and temporal scale

The spatial scale of this research presents a challenge in terms of the selection of informative indicators and the interpretation of indicator measures. Wright (2002) states: "Indicators must be chosen to represent systems at the target scale of interest and be adapted and tested in an appropriate context" (11-12). The WNMF (1999) indicators cover a range of spatial scales from very small (e.g. Proportion of unique features identified in the Natural Areas System Plan that are protected or subject to special management provisions) to very large (e.g. Area of suitable habitat for selected species). Interview subjects participating in the scoping interviews were asked to consider issues of scale in the context of their knowledge of the study area, and to select indicators that could provide meaningful information at the desired spatial scale. As well, during the second round of interviews, interview subjects were asked to explicitly consider issues of spatial scale in providing their interpretation of indicator measures.

Von Mirbach's paper *Reporting on Local Level Indicators: Barriers and Solutions (Draft)* (2000) summarized the experience of the preparing the *State of the Forest Report for the Western*

Newfoundland Model Forest (WNMF 2000). Von Mirbach (2000) notes that data were not always available at the desired spatial scale (i.e. the Western Newfoundland Model Forest Area.), which demanded an "approximation" be made. In some cases, data from other administrative districts were therefore used (e.g. Furbearer Zone 10 for lynx figures and Snowshoe Hare Zone 4 for snowshoe hare figures) which did not correspond precisely to their study area. As well, different data sets often had variation in the time period covered, as information on some indicators was gathered irregularly. Von Mirbach (2000) notes that the *State of the Forest Report* (2000) was guided by the principles of providing the most up-to-date and accurate information, and where possible, aimed to show trends over time. Consequently, each indicator measured in the *State of the Forest Report* (2000) was handled differently. Von Mirbach (2000) concludes, "this approach has the significant benefit of reporting the *best* and *most meaningful* information for each indicator; an advantage that significantly outweighs the disadvantage of having inconsistencies between indicators."

4 – Study Area Description

The study area selected includes forestlands held by each of the three major forest tenure holders on the island of Newfoundland (ACCC, CBPP and the Crown), within the same regional planning unit. Ecological conditions across the study area are fairly consistent, with the majority of all three tenure holder land located within the North Central subregion.

4.1 – Geographic description

The study area for this research is Forest Management Districts 4, 5, and 6, in north-eastern Newfoundland (see Figure 3). The total area of the three districts is approximately 1,300,000 hectares, with a total productive forest area of approximately 449,857 hectares (Government of Newfoundland and Labrador 2002b).

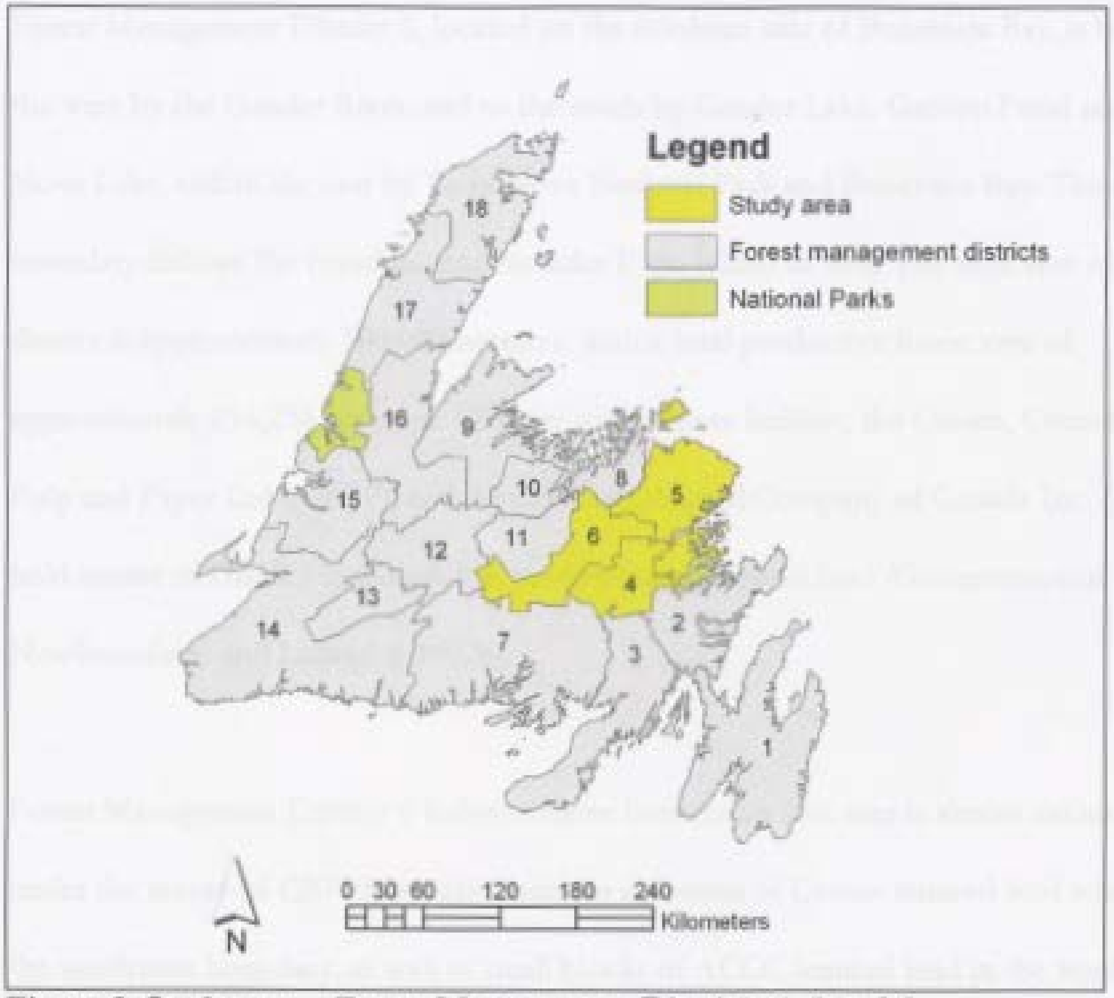

Figure 3: Study area – Forest Management Districts 4, 5 and 6

Forest Management District 4 covers an area of approximately 300,000 hectares with a productive forest area of approximately 82,785 hectares. The boundaries of District 4 mirror forest tenure boundaries[9] (the district is almost exclusively under tenure to Abitibi Consolidated Company of Canada Inc.), and include a portion of the Bay du Nord Wilderness Reserve and Middle Ridge Wildlife Reserve in the south (Government of Newfoundland and Labrador 2002b).

[9] Note that forest management district boundaries do not tend to follow ecological boundaries (e.g. watershed boundaries, ecoregions, etc.).

Forest Management District 5, located on the northern side of Bonavista Bay, is bound to the west by the Gander River, and to the south by Gander Lake, Gambo Pond and Terra Nova Lake, and to the east by Terra Nova National Park and Bonavista Bay. The northern boundary follows the coastline, and includes Fogo Island as well. The total area of the district is approximately 580,000 hectares, with a total productive forest area of approximately 214,254 hectares. All three main tenure holders, the Crown, Corner Brook Pulp and Paper Ltd. (CBPP), and Abitibi Consolidated Company of Canada Inc. (ACCC), hold tenure in District 5, though it is predominantly Crown land (Government of Newfoundland and Labrador 2002b).

Forest Management District 6 follows tenure boundaries (the area is almost exclusively under the tenure of CBPP), but also includes a portion of Crown tenured land which forms the southwest boundary, as well as small blocks of ACCC tenured land in the north. The area is approximately 440,000 hectares, with a total productive forest area of approximately 152,818 hectares (Government of Newfoundland and Labrador 2002b). Figure 4 and Table 2 outline the forest tenure distribution per management district, and for the study area as a whole. To reference selected place names and water bodies within the study area, see Appendix 2.

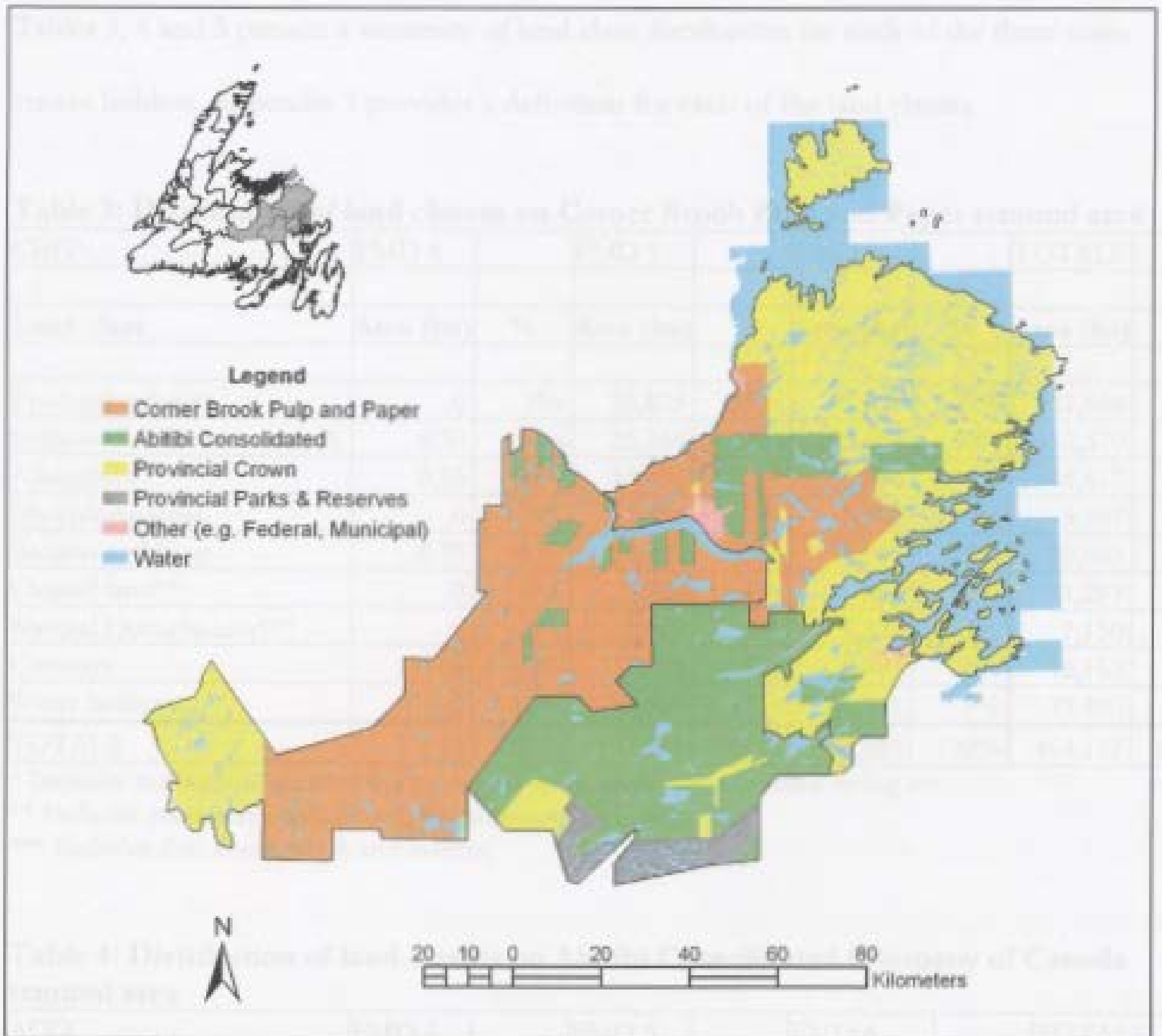

Figure 4: Distribution of forest tenure within study area

Table 2: Total area (including water bodies) per tenure holder for each management district in the study area (Source: Department of Natural Resources, Forestry Branch, Newfoundland Forest Stand Inventory (2002)).

District	Tenure holder										Total area
	CBPP		ACCC		Crown		Parks and reserves		Other*		
	Area	%	Area	%	Area	%	Area	%	Area	%	
4	1.7	<1	243,433	81	20,212	7	36,463	12	--	-	300,111
5	105,276	19	64,533	11	396,701	69	780	<1	8,214	1	575,504
6	356,900	81	19,967	5	63,110	14	108	<1	--	-	440,086
Total	464,187	35	327,951	25	480,023	36	37,747	3	8,214	1	1,318,108

*Other: Consists of Federal Crown, Municipal Crown, and Private Land.

Tables 3, 4 and 5 present a summary of land class distribution for each of the three main tenure holders. Appendix 3 provides a definition for each of the land classes.

Table 3: Distribution of land classes on Corner Brook Pulp and Paper tenured area

CBPP	FMD 4		FMD 5		FMD 6		TOTALS	
Land class	**Area (ha)**	%	**Area (ha)**	%	**Area (ha)**	%	**Area (ha)**	%
Productive forest	0	0%	35,825	33%	97,029	27%	132,854	29%
Softwood / hardwood scrub	0.30	17%	23,766	22%	108,604	30%	132,370	29%
Alienations*	0.35	20%	10,750	10%	33,866	9%	44,617	10%
Silviculture areas	0	0%	1,654	2%	3,943	1%	5,597	1%
Barrens and bogs	0.70	41%	13,702	13%	76,961	22%	90,663	20%
Cleared land**	0	0%	720	1%	564	0%	1,283	0%
Natural Disturbances***	0	0%	1,925	2%	5,225	1%	7,150	2%
Cutovers	0.05	3%	7,272	7%	8,881	2%	16,153	3%
Water bodies	0	19%	11,669	11%	21,821	6%	33,490	7%
TOTALS	1.73	100%	107,282	100%	356,893	100%	464,177	100%

* Includes buffer zones, candidate protected areas, areas uneconomical to log etc..
** Includes residential, agricultural, transmission lines, etc..
*** Includes fire, flood, wind, and insects.

Table 4: Distribution of land classes on Abitibi Consolidated Company of Canada tenured area

ACCC	FMD 4		FMD 5		FMD 6		TOTALS	
Land class	**Area (ha)**	%	**Area (ha)**	%	**Area (ha)**	%	**Area (ha)**	%
Productive forest	48,396	20%	14,005	22%	8,927	45%	71,328	22%
Softwood / hardwood scrub	80,920	33%	13,642	21%	4,313	22%	98,875	30%
Alienations*	21,849	9%	8,525	13%	2,582	13%	32,957	10%
Silviculture areas	1,210	0%	1,266	2%	21	0%	2,496	1%
Barrens and bogs	60,756	25%	13,184	20%	2,486	12%	76,427	23%
Cleared land**	205	0%	212	0%	190	1%	607	0%
Natural Disturbances***	7,082	3%	1,078	2%	503	3%	8,663	3%
Cutovers	4,445	2%	4,005	6%	41	0%	8,490	3%
Water bodies	18,591	8%	8,632	13%	904	5%	28,127	9%
TOTALS	243,453	100%	64,550	100%	19,967	100%	327,970	100%

* Includes buffer zones, candidate protected areas, areas uneconomical to log etc..
** Includes residential, agricultural, transmission lines, etc..
*** Includes fire, flood, wind, and insects.

Table 5: Distribution of land classes on Crown tenured area

CROWN	FMD 4		FMD 5		FMD 6		TOTALS	
Land class	**Area (ha)**	%	**Area (ha)**	%	**Area (ha)**	%	**Area (ha)**	%
Productive forest	668	3%	36,272	9%	381	1%	37,321	8%
Softwood / hardwood scrub	5,479	27%	102,676	26%	24,062	38%	132,216	28%
Alienations*	1,623	8%	57,467	14%	8,340	13%	67,430	14%
Silviculture areas	0	0%	2,951	1%	0	0%	2,951	1%
Barrens and bogs	11,151	55%	127,954	32%	21,776	35%	160,881	34%
Cleared land**	0	0%	4,447	1%	11	0%	4,458	1%
Natural Disturbances***	87	0%	5,385	1%	36	0%	5,508	1%
Cutovers	0	0%	11,089	3%	0	0%	11,089	2%
Water bodies	1,204	6%	48,455	12%	8,503	13%	58,162	12%
TOTALS	20,212	100%	396,696	100%	63,109	100%	480,017	100%

* Includes buffer zones, candidate protected areas, areas uneconomical to log etc..
** Includes residential, agricultural, transmission lines, etc..
*** Includes fire, flood, wind, and insects.

The study area falls within four distinct ecoregions (see Figures 5 and 6), as identified by Damman (1983): Central Newfoundland Ecoregion – Northcentral Subregion (IIA), North Shore Ecoregion (III), Maritime Barrens Ecoregion – Central Barrens Subregion (VID) and Eastern Hyper-Oceanic Barrens Ecoregion (VII). Damman (1983) defines an ecoregion as an area with a "distinctive, recurring pattern of vegetation and soil development which is controlled by regional climate" (164).

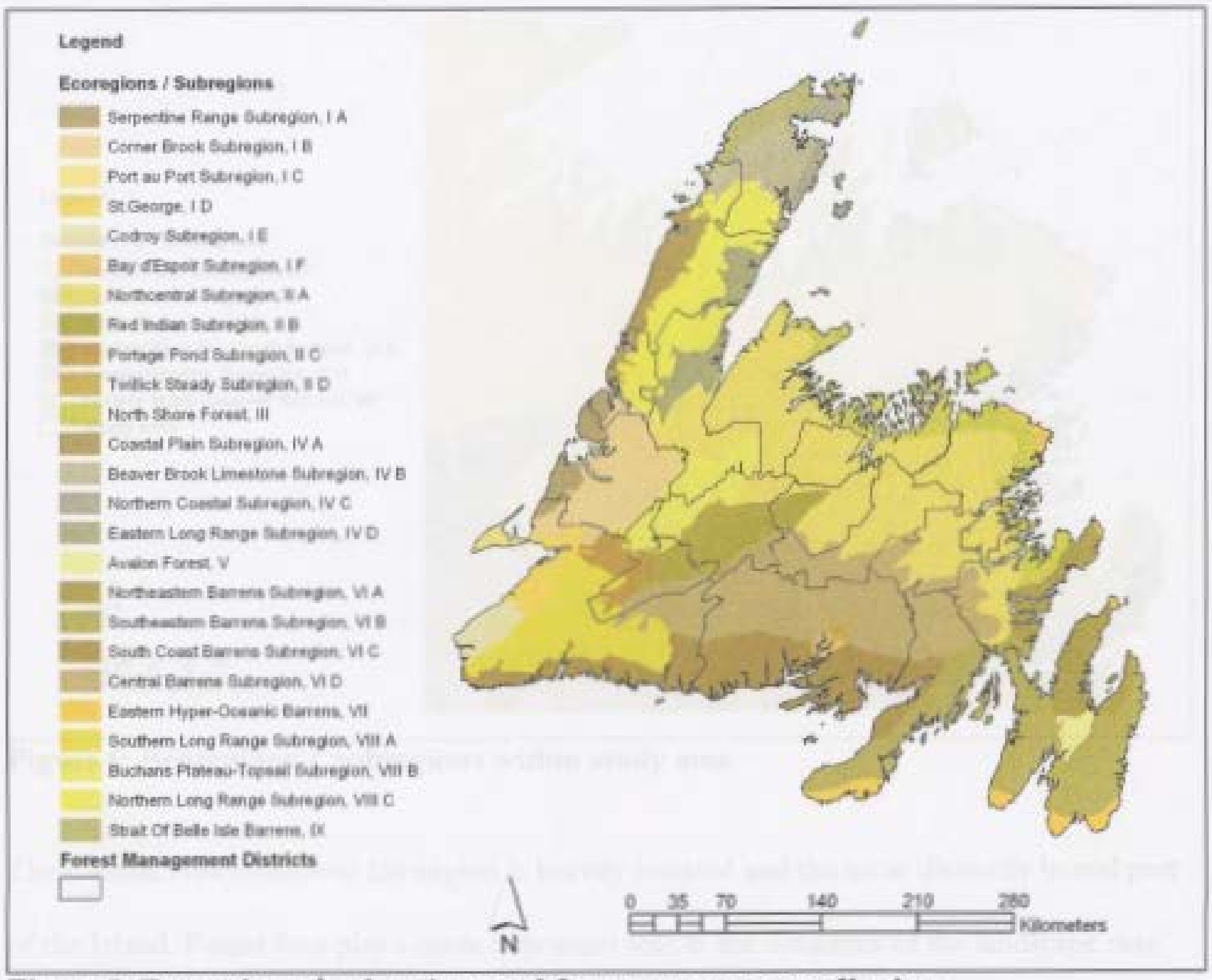

Figure 5: Ecoregions / subregions and forest management districts

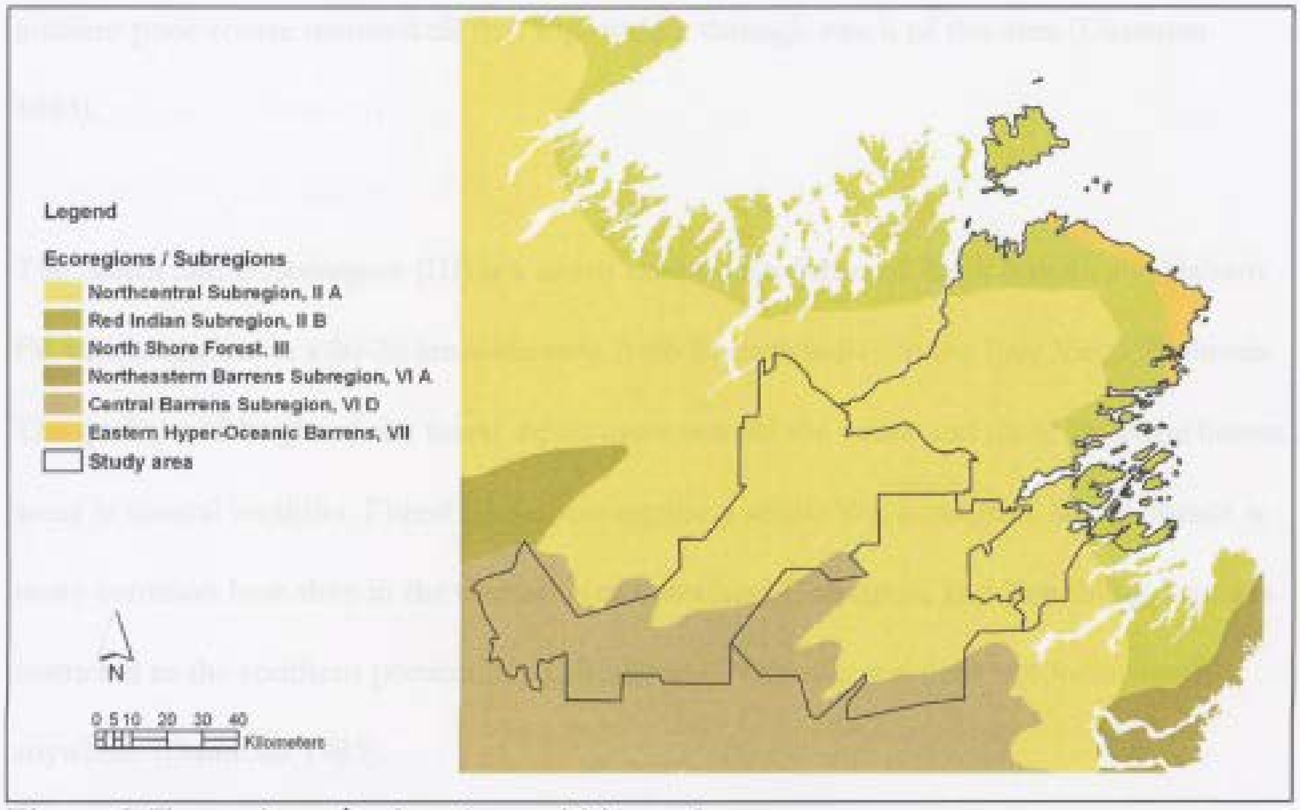

Figure 6: Ecoregions / subregions within study area

The Central Newfoundland Ecoregion is heavily forested and the most distinctly boreal part of the Island. Forest fires play a more important role in the dynamics of the landscape than any other region of the Island (Damman 1983). Much of the Balsam Fir-Feathermoss forest types have been converted to Black Spruce, and some of the richer sites to hardwood forests, dominated by White Birch and Trembling Aspen (Meades and Moores 1994). Red Pine is restricted to this ecoregion, while Yellow Birch is completely absent (Damman 1983). The Northcentral Subregion (IIA), one of four subregions within the Central Newfoundland Ecoregion, extends from Clarenville to Deer Lake. It has the highest maximum temperatures and lowest rainfall in Newfoundland. It also has the highest frequency of forest fire, evident by stands of pure Black Spruce forest and Trembling Aspen which dominate the region. This subregion is particularly susceptible to regeneration failure, given low moisture, coarse soils and the prevalence of Black Spruce cover types. Where tree regeneration is lacking, succession to dwarf shrub heath dominated by Sheep Laurel (*Kalmia angustifolia*) occurs on nutrient poor coarse textured till that is prevalent through much of this area (Damman 1983).

The North Shore Ecoregion (III) is a nearly continuous forest of Black Spruce and Balsam Fir which extends in a 20-25 km wide strip from Bonavista Bay to the Baie Verte Peninsula. The quality and height of the forest deteriorates toward the coast, and there are some barren areas in coastal localities. Forest fires occur regularly within this ecoregion. White Spruce is more common here than in the Central Newfoundland Ecoregion, and Trembling Aspen is restricted to the southern portion of the Bonavista Peninsula and does not form stands anywhere (Damman 1983).

The Maritime Barrens Ecoregion covers a large area including the majority of the Avalon Peninsula, and extends westward across the southern portion of the Island towards Port-aux-Basque. The ecoregion features extensive barren areas consisting of dwarf shrub heaths, bogs and shallow fens. The area was formerly extensively forested, but today, Balsam Fir dominant forest is isolated to small patches usually found in valleys and occasionally on hilltops and slopes. The Central Barrens Subregion (VID) includes the barrens located between the forests of the Northcentral Subregion (IIA) and the fog prone barrens of the Southcoast Subregion (VIC). Forest patches occur throughout the subregion, which has less frequent fog, warmer summers and more reliable snow cover than the other subregions within this ecoregion (Damman 1983).

The Eastern Hyper-Oceanic Barrens Ecoregion is located on the coastal areas of the Bonavista North Peninsula, the southern coasts of the Avalon and Burin peninsulas, as well as the northeast coast near Bay de Verde. The extreme oceanic climate limits the development of forest other than "tuckamore" or Balsam Fir krummholz (Government of Newfoundland and Labrador 2002b, 15-16).

Figure 7 and Table 6 summarise the distribution of ecoregions and subregions in relation to forest tenure within the study area.

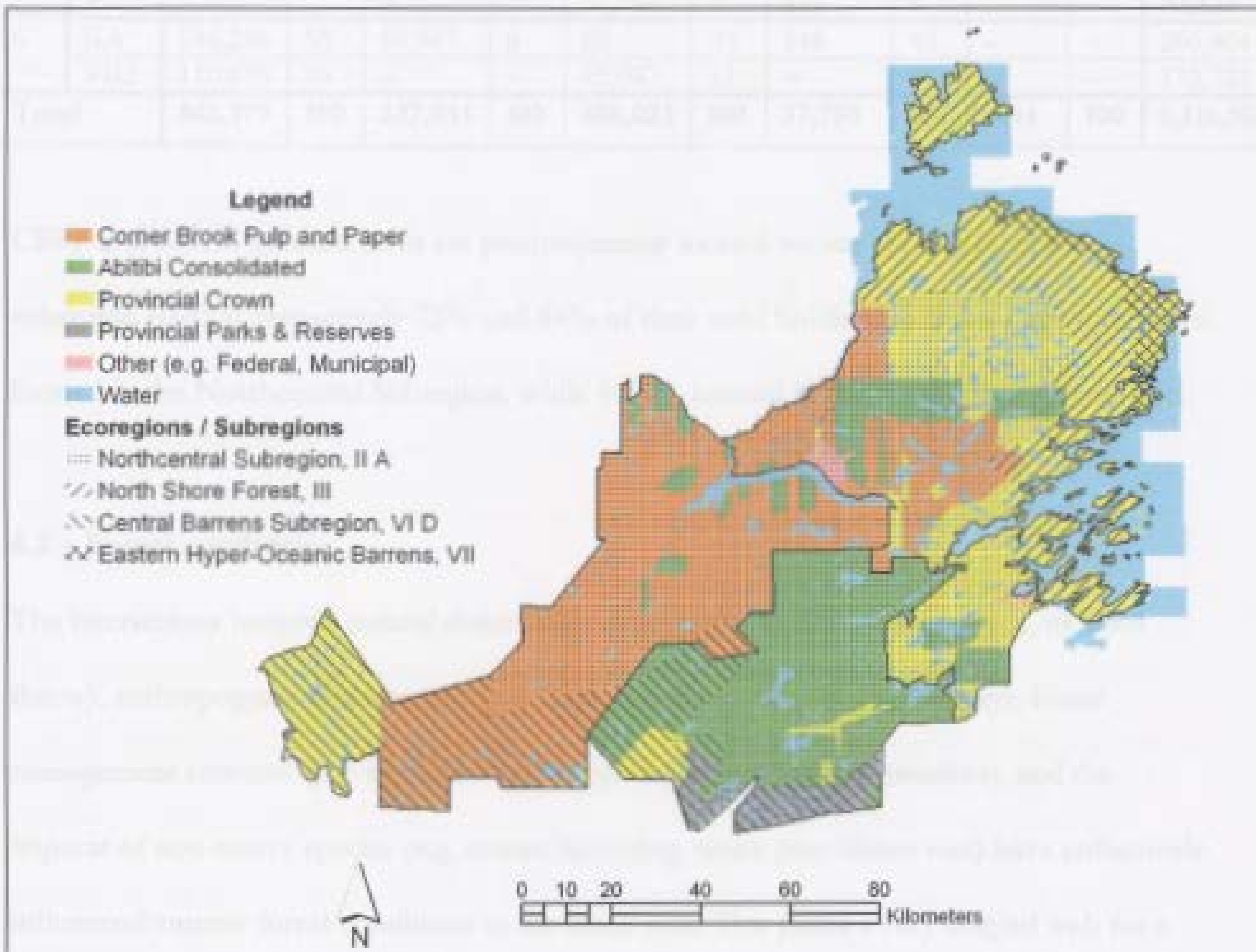

Figure 7: Distribution of Ecoregions / subregions and forest tenure within study area

Table 6: Distribution of tenure by Ecoregion / subregion (Data Source: Department of Natural Resources, Forestry Branch, Newfoundland Forest Stand Inventory (2002)).

District	Ecoregions / subregions	Tenure holder										Total area
		CBPP		ACCC		Crown		Parks and reserves		Other		
		Area	%	Area	%	Area	%	Area	%	Area	%	
4	IIA	2	<1	192,532	59	5874	1	2086	6	--	--	200,494
	VID	--	--	50,902	16	14,338	3	34,403	91	--	--	99,643
5	IIA	102,496	22	63,208	19	173,571	36	679	2	8046	98	348,000
	III	2780	1	1325	<1	190,144	40	--		168	2	194,417
	VII	--		--		32,986	7	437	1			33,423
6	IIA	246,226	53	19,967	6	63	<1	148	<1	--	--	266,404
	VID	110,675	24	--	--	63,047	13	--	--	--	--	173,722
Total		**462,179**	**100**	**327,934**	**100**	**480,023**	**100**	**37,753**	**100**	**8214**	**100**	**1,316,103**

CBPP and ACCC tenured lands are predominantly located within the Northcentral subregion (IIA) at respectively 75% and 84% of their total holdings. 37% of Crown tenure is located in the Northcentral Subregion, while 40% is located in the North Shore Ecoregion.

4.2 – Forest condition

The interactions between natural disturbance events (e.g. wildfire, insect attack, or wind throw), anthropogenic disturbances (e.g. human-induced fire, logging history), forest management activities (e.g. fire and insect suppression, silviculture practices), and the impacts of non-native species (e.g. moose browsing, white pine blister rust) have collectively influenced current forest conditions in the study area. This poses a very tangled web for a forest researcher attempting to understand the relative influence of forest tenure on forest condition.

Amongst various natural disturbances in the study area the most predominant have been forest fire and insect damage. Succession following these disturbances (especially following fire) has favoured the development of Black Spruce forests and Aspen stands (Government of Newfoundland and Labrador 2002b, 38). In areas of nutrient-poor, coarse-textured till, which is prevalent throughout much of the three districts, succession can tend towards dwarf shrub heath dominated by Sheep Laurel (Damman 1983). Power (1996) notes that much of the forest within the Terra Nova National Park area (on the eastern boundary of the study area) reflects an origin corresponding to fires started during the establishment of the cross Island railway in the early 20th century. The fire history for the study area includes a very large fire of 520,000 hectares, which occurred in 1867 in the vicinity of Gander Lake (Wilton and Evans 1974). The largest recent fire within the study area occurred in 1961 primarily on the Bonavista North Peninsula, covering an area of 289,045 hectares (Government of Newfoundland and Labrador 2000b, 20). A large fire at Gambo Pond occurred in 1979 where 23,045 hectares burned (Power 1996). In examining the region in and around Terra Nova National Park, Power (1996) notes that the rate of forest renewal by fire was greater in the past than it is at present.

The most prominent human-caused disturbances have been logging and human-induced fires. Extensive lumbering activities were carried out in the Gambo region during the 1800s. Similarly, the Terra Nova River Watershed (Forest Management District 4 region) was extensively logged for pulpwood and lumber through the 1940s and 1950s (Government of Newfoundland and Labrador 2002b, 6). Extensive logging has also been carried out over the 20th century in the Northwest and Southwest Gander Rivers (Forest Management District 6 region) (Government of Newfoundland and Labrador 2002b, 7).

The age-class distribution for each management district in the study area is summarised in Figures 8, 9, and 10. It should be noted that this summary does not include all forests within the study area, but only those that are classified as commercially productive[10]. Age classes are divided into twenty year increments as follows: Class 1 (0-20 years), Class 2 (21-40 years), Class 3 (41-60 years), Class 4 (61-80 years), Class 5 (81+ years).

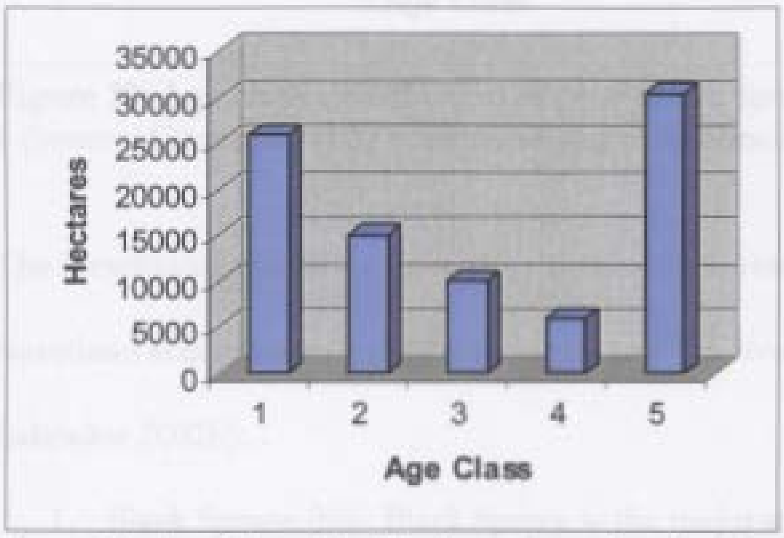

Figure 8: Age class distribution of productive forests in Forest Management District 4 (Source: Government of Newfoundland and Labrador 2002b, 24).

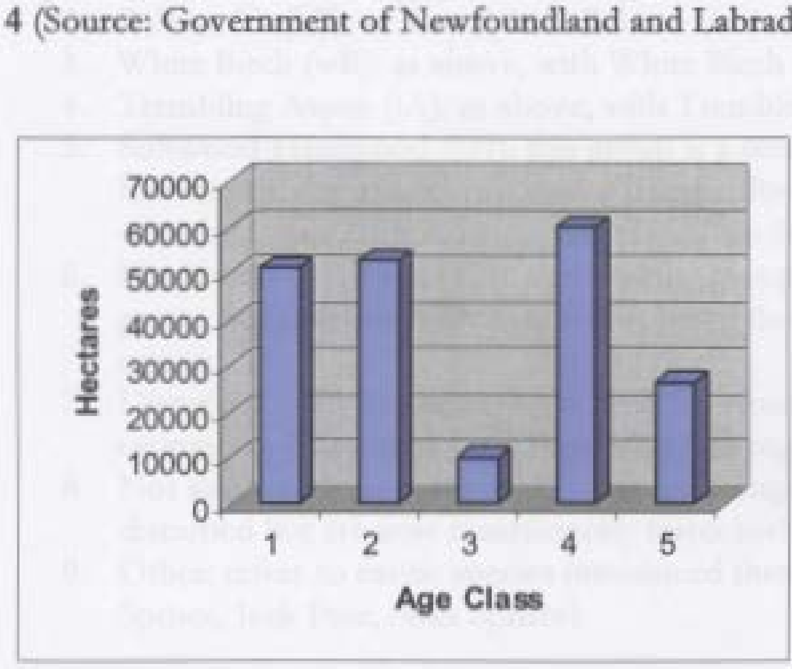

Figure 9: Age class distribution of productive forests in Forest Management District 5 (Source: Government of Newfoundland and Labrador 2002b, 25).

[10] See note 2, page 8.

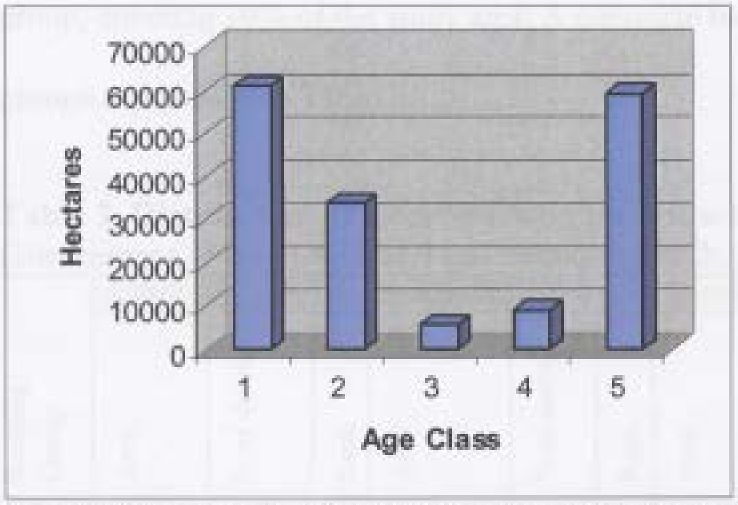

Figure 10: Age class distribution of productive forests in Forest Management District 6 (Source: Government of Newfoundland and Labrador 2002b, 26).

The Newfoundland Forest Inventory catalogues forest stand composition on productive forestland according to eight "working groups" (Government of Newfoundland and Labrador 2002b):

1. Black Spruce (bS): Black Spruce is the major species in this working group, making up to 75-100% of the basal area;
2. Balsam Fir (bF): as above, with Balsam Fir as the major species;
3. White Birch (wB): as above, with White Birch as the major species;
4. Trembling Aspen (tA): as above, with Trembling Aspen as the major species;
5. Softwood-Hardwood (SH): this group is a combination of softwoods and hardwoods, the major component being softwood (Balsam Fir and Black Spruce) with the minor component consisting of hardwoods;
6. Hardwood-Softwood (HS): the working group is essentially the same as the SH group, but reversed with hardwoods being the major component and softwoods the minor;
7. Disturbed (DI): this grouping is used for areas that are disturbed (e.g. by wind, fire, or insects). It is unknown if these sites will regenerate;
8. Not sufficiently restocked (NS): this grouping refers to areas that have been disturbed but are now insufficiently restocked with a preferred species;
9. Other: refers to exotic species introduced through plantation trials (i.e. Englemann Spruce, Jack Pine, Sitka Spruce).

The predominant working group within the study area is Black Spruce, which comprises 63% of the area. DI (unclassified disturbance) is the second most predominant working group, covering 10% of the study area. A complete breakdown of productive forest working groups is provided in Table 7.

Table 7: Distribution of forest working groups within the study area (Source: Government of Newfoundland and Labrador 2002b, 22).

Working Group	District 4			District 5			District 6			Total area by working group	% of three districts	Rank
	Area	% of district	Rank	Area	% of district	Rank	Area	% of district	Rank			
BF	6187	7	3	12,035	6	5	14,806	9	2	33,028	7	3
BS	65,153	74	1	105,199	52	1	121,494	72	1	291,846	64	1
DI	8275	9	2	27,483	14	2	11,952	7	3	47,710	10	2
NS	3925	4	4	10,872	5	6	4992	3	5	19,789	4	6
HS	1179	1	6	13,992	7	4	8157	5	4	23,329	5	5
SH	1785	2	5	23,930	12	3	3911	2	6	29,627	6	4
WB	1017	1	7	7974	4	7	3490	2	7	12,480	3	7
TA	25	0	9	789	0	8	123	0	8	937	0	8
Other	32	0	8			9	2	0	9	34	0	9
Total	87,579	100		202,274	100		168,927	100		458,780	100	

It is worth noting that White Pine was historically more prevalent in the study area, and likewise across the Island. Prowse (1911) describes a "Pine belt" covering an area of 5200 km^2 running from Botwood to Gambo. As Munro (1978, 76) notes, Newfoundland's lumber exports totalled 22 million board feet in 1904, with an industry primarily focused on the liquidation of White Pine in the central part of the Island. Power (2000) estimates that 112,500 individual White Pine trees were logged from the Pine belt in a 20-year span at the turn of the 20th century. He concludes: "From the scattered occurrence of Pine today it is evident that this rate of harvest was not sustainable" (Power 2000, 35). Red Pine is another rare tree species occurring in approximately 22 locations in central Newfoundland, including approximately eight within the study area (Government of Newfoundland and Labrador 2002b, 41).

4.3 – Animal distribution

The study area has favourable habitat conditions for the full range of mammals present on the Island (Government of Newfoundland and Labrador 2002b, 29). This includes species such as Woodland Caribou, Moose, Beaver, Lynx, Mink, Red Fox, Artic Fox, and River Otter, amongst others. The Forest Ecosystem Strategy Document for Districts 4, 5, and 6 (Government of Newfoundland and Labrador 2002b) states: "it is assumed that the area contains normal populations for each of these species" (29). The Newfoundland Marten however, is a species of concern for forest management in the study area. This small, fur-bearing animal requires specific habitat conditions – typically older forest stands with complex structure – to maintain healthy, stable populations (Government of Newfoundland and Labrador 2002b, 11). The Newfoundland population of this species is listed as *endangered* under provincial Endangered Species Act (2001) and federal Species at Risk Act (2002).

Several avian species rely heavily on forested habitats year-round, including species of woodpecker, hawk, owl, finch and chickadees. Other species require forested habitat for nesting, but appear to be less reliant on it for foraging or winter habitats. They include Osprey, Bald Eagle, Canada Jay, Blue Jay, and species of owls (Government of Newfoundland and Labrador 2002b, 29).

Freshwater fish species in the region include Artic Char, Atlantic Salmon, and Brook Trout (Meades 1990), amongst others. There are 13 scheduled waters for salmon in the three management districts.

4.4 – Human population

Approximately 45,000 people live in the region bounded by Forest Management Districts 4, 5, and 6. Most communities are disbursed around the coastline, with the major population centre based in Gander (approximately 12,000 inhabitants in 2002). Communities were settled around the fishery, railway operation, lumbering, and trans-Atlantic air travel in the case of Gander. Domestic logging continues to be an important forest use with approximately 2000 domestic cutting permits issued for Crown land in District 5 each year. Other forest uses include outfitting, berry picking, hunting, trapping, fishing, hiking, camping, skiing, and snowmobiling (Government of Newfoundland and Labrador 2002b, 6, 28).

4.5 – Forestry regime in study area: forest laws and the exercise of property rights

Forest property rights held by CBPP within the study area are of two types: License (86%) and Special License Reid Lot Purchase (14%). The licenses in the "Gander Valley" region, which roughly correspond to Forest Management District 6, were acquired in 1938 by Bowaters Ltd. (Government of Newfoundland and Labrador 2002b, 7). All of CBPP's licenses are consolidated under the *Bowater's Newfoundland Act* (1938), which "vest[s] in the holder thereof all right of property whatsoever in all trees and timber cut within the limit of the license…". These licenses expire in 2037.

ACCC's property rights within the study area are of two types: Freehold (1%) and License (99%). ACCC's predecessor, the Anglo-Newfoundland Development Company obtained the rights to the "Terra Nova limits", which roughly correspond to Forest Management District 4, in 1923 (Government of Newfoundland and Labrador 2002b, 7). The licenses, now held by ACCC, grant the company the right to cut timber, and expire in 2010 (*Forestry Act 1990).* Freehold land is land that has been purchased by the company, and therefore confers exclusive, comprehensive property rights to ACCC. Since 1994, the Crown has managed District 4 forests on behalf of ACCC, under a "Crown Land Exchange". Under this arrangement ACCC retains tenure over the land, and purchases wood cut by Crown Land Operators. The Crown is responsible for carrying out all management activities, including preparation of management plans, silviculture, monitoring, etc. This arrangement allows ACCC to save on management costs, while the Crown benefits by being able to better supply integrated sawmills on the Bonavista Peninsula with sawlogs. A Crown Land Exchange has been recently negotiated for ACCC's holdings within District 6.

The distribution of tenure type in each forest management district is provided in Table 8[11].

[11] It should be noted that this thesis is not scaled to examine differences in Private, License, and Special License tenured lands. Tenure type data are aggregated for each company and analysis focuses on differences in forest health and biodiversity amongst each tenure holder (CBPP, ACCC and the Crown).

Table 8: Tenure type per Forest Management District (Source: Department of Natural Resources, Forestry Branch, Newfoundland Forest Stand Inventory (2002)).

District	Tenure type	CBPP (hectares)	%	ACCC (hectares)	%
4	Private			96	0%
	License	1.7	100%	24,3337	100%
	Special License				
5	Private			1504	2%
	License	77,373	72%	63,046	98%
	Special License	29,911	28%		
6	Private			2567	13%
	License	322,944	90%	17,397	87%
	Special License	33,956	10%		
TOTALS	Private			41,676	1%
	License	400,319	86%	323,781	99%
	Special License	63,867	14%		

As previously noted, property rights in combination with a broad suite of legislation (e.g. *Forestry Act 1990, Fisheries Act 2004, Endangered Species Act 2001, Environmental Protection Act 2002*) compose a regulatory regime, which both facilitates and constrains the exercise of forest property rights within Forest Management Districts 4, 5, and 6. Though CBPP and ACCC hold exclusive cutting rights on their tenured area, they are nonetheless constrained in their operations by regulatory guidelines such as annual allowable cut rates, appurtenance requirements, specific logging practices, environmental protection measures, etc..

The general public can also influence how the companies and the Crown exercise their forest property rights. Five-year forest operating plans describing all forestry-related activities (e.g. logging, road construction, silviculture activities, ecological monitoring, etc.), are developed by each tenure holder for each management district, with the input of public planning teams.

Planning teams meet over a period of several months in order to develop operating plans for their management district(s). The public planning process on the Island's 18 forest management districts allows members of the public, or representatives of organisations to address concerns they might have about forest management within any one district.

The public planning team process, however, does not allow the public to influence all aspects of forest management within a district. Annual Allowable Cut (AAC) figures, which set a cap on how much timber may be removed from an area on an annual basis, are predetermined for each tenure holder per management district. Government foresters, in consultation with CBPP and ACCC, calculate AAC figures every five years, taking into account changes in the forest land base due to natural or human disturbance, projected tree growth, silviculture efforts, and expected successional patterns.

Competing land-uses or land-use proposals can also constrain the exercise of forest property by any of the three principle tenure holders. The forest land base can come under pressure by proposals for new cabins, roads, mines, protected areas, agriculture areas, tourism hydro development projects, etc..

The province is ultimately responsible for upholding forest management standards according to legislative requirements and policy goals. All five-year operating plans must pass the provincial environmental assessment process.

4.6 – Rationale for study area selection

This study area has been selected based on its representation of the three main tenure holders in Newfoundland, and relatively similar ecological conditions across the tenure boundaries. Given the long-history of domestic logging in coastal areas, and industrial logging in the interior, this region can be viewed as representative of forestry activities across Newfoundland. Forest Management Districts 4, 5, and 6 also compose a single regional planning unit, guided by a public planning team.

As noted above, CBPP and ACCC tenured lands are predominantly located within the Northcentral subregion (IIA) at respectively 75% and 84% of their total holdings. 37% of Crown tenure is located in the Northcentral Subregion, while 40% is located in the North Shore Ecoregion. This is characteristic of forest tenure distribution across Newfoundland. As illustrated in Figure 1, company tenured lands tend to be concentrated in the richly forested interior, while Crown lands are located in coastal regions. GIS analysis focuses on the "productive forests" of each tenure holder, thereby attempting to minimize confounding differences in the ecological character of Crown and company lands.

This planning unit was also selected because it borders on Terra Nova National Park. This park is predominantly located in the Northcentral Subregion, with coastal areas located in the North Shore Ecoregion. As such it contains the same forest site types as found in the study area, and is used as a reference value for some indicator measures in the GIS analysis.

5 – Results and Discussion

Part one of this chapter summarizes the results of the first round of interviews. The first round of interviews served as a scoping phase for the thesis. Nine experts in the fields of forest management and forest ecology were individually interviewed with the purpose of gathering preliminary information on the relative influence of property rights on forest health and biodiversity in Newfoundland and in the study area; and to assist in the selection of indicators to serve as an evaluation framework for the research. Interviewees included three Crown forest managers, two pulp and paper sector representatives, one Crown forest ecologist, one academic forest ecologist, one academic forest management expert, and one representative of a non-governmental environmental organisation. All materials provided to the interview subjects, including background information and questionnaire, are in Appendix 1.

The second part of this chapter summarizes the measurement and interpretation results for each of the five selected indicators. For each of the selected indicators, a rationale is provided for the measurement methods and reference values employed. Wright (2002) recommends that reference values be determined through a collaborative process such as a group discussion, as various reference values could be in conflict with one another. Wright (2002) also suggests that the interpretation of indicator measures should predominantly be "narrative in nature", drawing on the perspectives of multiple stakeholders. Though a group discussion of interviewees would have been the preferred approach for this thesis, logistical constraints did not permit it. Instead, individual interviews were carried out with those participants from the scoping phase of interviews that were most familiar with the study area in question. They included one academic forest ecologist, one Crown forest manager, one

Crown forest ecologist, and two pulp and paper sector representatives. Interviewees were asked to comment on the measurement methods, reference values and measurement results for each indicator. Results from the second round of interviews are incorporated in discussion of each indicator. It should be noted that discussion and interpretation sections of this chapter are not intended to be exhaustive, but simply offer possible explanations (which can sometimes conflict) for the indicator results by drawing on the knowledge and perspectives of the interviewees.

5.1 – Results of scoping interviews

5.1.1 – The potential influence of forest property rights on forest health and biodiversity in Newfoundland

Interview subjects[12] expressed a variety of opinions on if and how forest property rights might influence forest health and biodiversity in Newfoundland. Unless specified, comments from interviewees generally refer to the Newfoundland forest management regime as a whole and are not specific to the study area in question. The opinions expressed correspond in part to two of the three hypotheses that have been drawn from the literature review (Chapter 2).

The first hypothesis states that as "companies have no incentive to attempt to produce … non-timber outputs in a positive fashion" (Nelson *et al* 2003, 243), biodiversity and

[12] To maintain confidentiality, interview subjects are only identified by organisational or sectoral affiliation.

ecosystem health are underprovided on forestlands under license, lease and freehold tenure of CBPP and ACCC. None of the interviewees expressed this view[13].

The second hypothesis states that forest biodiversity and ecosystem health are maintained similarly on all forestlands (Crown and company-tenured areas) in Newfoundland and Labrador, due to a forest management regime based on public participation and strict regulations. Several of the interviewees offered this hypothesis or a variation thereof, making statements such as that offered by a Crown forest manager: "It [forest property rights] doesn't influence [forest health] because, regardless of your land tenure, you're going to prepare a management plan as to how you're going to manage your resource. That has to be consistent with our [government's] legislation, regulations, and guidelines. That's also a public process... [and] all 5-year plans go through an environmental assessment review ... so in terms of making sure in regards of the tenure, how we address biodiversity issues, I don't think the tenure matters."

The final hypothesis states that any differences in biodiversity and ecosystem health on CBPP forests, ACCC forests, or Crown forests are "determined by the actors, their preferences, and the *de facto* institutions operating on the ground" (Gibson *et al* 2002), and are not a result of the type of property rights *per se.* One interviewee representing a non-governmental environmental organisation echoed this hypothesis by stating: "I've been involved a little bit and seen planning processes that have been led by the Crown and led by the companies, and basically there are not a lot of differences, because it's part of the policy in Newfoundland. Every one has to do a planning team and go through the planning

[13] It should be noted however, that interview subjects were not asked to respond to the three hypotheses presented in Chapter 2, but volunteer their own thoughts and opinions on the subject.

process. The main difference isn't the particular rights, but has to do with the qualities and the characteristics of the people leading the process. In my experience there are good and bad foresters working for the Crown and there are good and bad foresters working for the paper companies."

Interviewees pointed to a variety of other ways however, that property rights might influence forest health and biodiversity, including cutting practices, the size of tenure blocks, issues of compensation, enforcement capacity, pressures on the land base, and land use changes.

Cutting practices

In reference to differences in cutting and silviculture practices, a Crown forest ecologist stated that, "Tenure could affect biodiversity in that on the licensed land they [the companies] are harvesting on a more frequent rotation across the entire set of their land base [as compared to Crown land]." An academic forest ecologist stated that there is a "younger forest age structure in much of the land leased to paper companies" and that "plantations are more common on company land."

Past and present differences in desired forest products from Crown and company land (i.e. for domestic needs versus pulpwood), and associated cutting practices, are also named as having a potential influence on forest health and biodiversity. As a Crown forest manager explained: "The Crown areas probably have a higher degree of long-term use. There's probably been hundreds of years of activity on the Avalon Peninsula for example, or the Bonavista Peninsula. While the interior forest, where the pulp and paper companies operate, have been primarily harvested over the last 70-100 years. The type of harvesting is much more patch cutting and selective cutting [in domestic harvesting areas]. My thought would be at least from the perspective of vegetation, I think domestically harvested areas would be far more diverse than an industrial type forest, or a natural forest, because they would have much more vertical structure, much more varied age class, much greater range of tree species and plant species." Differences caused by the selective cutting patterns on domestic harvest areas on Crown lands versus clear-cutting methods on company lands were noted by a Crown forest ecologist as having a potential influence on forest health and biodiversity, but they were unsure of the effect. "There are differences, but I don't know in terms of one having a bigger impact on forest health and biodiversity, one over the other. Habitat for species like woodpeckers and owls, those cavity nesters, may have a harder time in areas of Crown land where you've got domestic harvesting, because they [domestic wood cutters] tend to go in and take out those snags, which tend to be birch trees.... The companies aren't interested in hardwoods, they leave them."

In reference to commercial-scale harvesting on Crown lands, a Crown forest manager commented that, "More and more, the commercial harvests on Crown lands are similar to what companies are doing. The number of people out slinging a chainsaw for commercial operations is declining rapidly. Where you do have Crown commercial operations using harvesters and that type of gear, there's not a lot of difference [from operations on company lands]."

Size of tenure blocks

Another Crown forest manager noted that the small size of some of the tenure blocks within certain management districts can limit a tenure holder's flexibility in designing harvest plans, which therefore may result in negative impacts on sensitive species such as Newfoundland Marten or Woodland Caribou. They noted that the *Forestry Act* (1990) requires that harvesting be distributed based on tenure boundaries within districts. The result is that you "concentrate harvesting on particular locales". They explained that, "If you had a broader system of tenure, more related to ecosystem boundaries, you would definitely have a better chance of preserving or maintaining biodiversity and ecosystem health. The scheduling of harvesting is difficult enough, but you enter into the realm of tenure, and it makes it more difficult. In District 5, for example, Abitibi has no choice of where they're going to be because they have small tenure. District 6 is even worse for Abitibi. So the manoeuvrability of the company around that particular issue [critical habitat], given such small blocks, becomes difficult. District 4 is pretty well all Abitibi, so it's not so bad. I think the tenure system definitely has potential to have a significant influence on health and biodiversity."

Issues of compensation

Another Crown forest manager suggested that there is a potential relationship between tenure and forest health in the event of lost cutting rights due to establishment of protected areas. They stated, "When you come down to dealing with protected areas, and the actual legal sign off, there may be issues of compensation. Unlike on unalienated Crown land, there is an ownership issue with the trees. The companies have been granted a legal right [proprietorship of the trees] and the licenses are older. And there's none of this stuff [biodiversity conservation objectives] in those licenses, so the issue of compensation comes up, that we [government] have a legal responsibility to compensate."

Enforcement capacity

Differences in capacity to enforce regulations were pointed to by a pulp and paper sector representative stating, "In theory there should be no difference [between Crown and company management]. The regulations apply equally to all tenures. In a practical sense, my feeling is that the forest industry has more resources on the ground, supervision and checking, and both companies are certified to fairly rigorous environmental standards: both ISO 14001 Environmental Management System and the Canadian Standards Association Z809 Sustainable Forest Management Standard that require regular checking on biodiversity and those sort of things. I would say areas managed by the pulp and paper companies can probably look after biodiversity and forest health better just because of the resources available to the industry compared to say small Crown land contractors...."

Pressure on the land base

The interviewee representing the non-governmental environmental organisation pointed to the relative pressure on the land base as one of the main factors influencing forest health and biodiversity. They stated, "The factors would be to what extent are there pressures from up above, coming down, that are driving degradation of the land base. Companies are under pressure to bring in fibre at low cost, but then again, Crown operators are under pressure to supply all kinds of other people. So the real pressures and demands on that land base have more influence than whether or not it's a Crown plan or a company plan."

The relative pressure on Crown land (and Crown district forest managers) versus company lands was emphasized by a Crown forest manager. They explained: "If CBPP is working in Forest Management District 15, for example, and if three years into their five-year plan they find they're over-cutting their annual cut limit, they can quickly shift operations within the district so that at the end of the 5-year period they're balanced. Crown has much more difficulty because Crown operators are local, they live in the community, and stuff like that…it puts a lot more pressure on district managers to try and keep a lid on the harvesting within their district. And I wouldn't suggest that the Crown lands are being over-cut, but that there's more pressure on the Crown lands." Additionally, they suggested that the Crown is more likely to address other societal values related to the forest. They stated, "There's probably a greater openness on the Crown's part to consider other land-use values, leaving areas, wider buffers, and stuff like that."

Land-use changes

The academic forest ecologist suggested that land-use changes, both positive and negative from the perspective of forest health and biodiversity, occur more easily and frequently on Crown lands. They suggested that protected areas are established much more easily on Crown land than company land. As an example, they referenced the debate over designation of Rodney Pond versus Gambo Pond as an ecological reserve representative of the Northcentral Subregion[14]. The interviewee stated, "Gambo Pond is mostly Crown, Rodney Pond is mostly Kruger. And that's the difficulty. There's no other reason." But this interviewee also argued that conversions of forestlands to non-forest uses also occur more easily on Crown lands. They stated, "conversion of land to non-timber uses like agriculture or municipal areas is obviously more common on Crown land. Somebody said we're

[14] The planning team for Forest Management District 4, 5 and 6 has endorsed the Gambo Pond site instead of Rodney Pond for ecological reserve designation. The later is the preferred site proposed in the province's protected areas strategy (Newfoundland and Labrador 2000).

[government] going to work with these Agriculture Development Areas. Suddenly, that was the biggest stress on Crown land. I can't see the first areas picked as Agriculture Development Areas would have been Abitibi tenured land. That's just ridiculous."

5.1.2 – Selection of indicators

The 16 indicators from Criterion One and Criterion Two of the Western Newfoundland Model Forest's *Criteria and Indicators of Sustainable Forest Management* (1999) were presented to interview subjects in the scoping phase interviews. They were asked to rank the five indicators that would be most relevant and responsive to testing the influence of forest property rights on forest health and biodiversity within the study area. The five indicators that are highlighted in bold text in Table 9 ranked highest.

Table 9: Ranking of indicators for forest health and biodiversity resulting from scoping interviews

Indicators for forest health and biodiversity	Ranking
1. Proportion of each eco-region that is in a protected status. (District/Provincial)	**3**
2. Proportion of each eco-region that is barren, bog, forest and water. (District/Provincial)	11
3. Proportion of each protected area that is barren, bog, forest and water. (District/Provincial)	12
4. Proportion of unique features identified in the Natural Areas System Plan that are protected or subject to special management provisions. (Provincial)	7
5. Area of each forest type by age class. (District/Provincial)	**2**
6. Area of suitable habitat for selected species (including consideration of factors such as connectivity, fragmentation and existence of features such as snags, coarse woody debris, etc). (District/Provincial)	**1**
7. Known forest-dependent species classified as extinct, extirpated, endangered, threatened and vulnerable on national, provincial and local lists, including: a. Change in risk status of species b. Change in numbers of individuals for each species at risk. (District/Provincial).	10
8. Change in population level or ranges of selected species.	**5**

(District/Provincial)	
9. Genetic information (such as genetic diversity or inbreeding levels) about selected species. (Provincial)	13
10. Reproductive success or fecundity of selected species (eg. cow-calf ratio for moose and caribou; percentage of sufficiently restocked areas for softwood tree species). (Provincial)	9
11. Area and severity of insect, fire and disease disturbance, and succession pattern afterwards. (District/Provincial)	N/S*
12. Area and severity of human-caused disturbances (e.g., logging, air pollution, species introduction), and succession pattern afterwards. (District/Provincial)	4
13. Frequency, abundance and distribution of selected indicator species relative to natural cycles. (District/Provincial)	6
14. Mean Annual Increment (MAI). (District/Provincial)	N/S
15. Reproductive success or fecundity of selected species. (Provincial)	N/S
16. Land use changes, changes to total area of forest cover. (District/Provincial)	8

*N/S refers to indicators that were not selected by any interview subject.

5.2 – Results and interpretation of indicator measures

Measurement methods, reference values, and interpretation are provided for each of the five indicators selected through the scoping interviews. A second round of interviews provided input on the measurement methods, reference values and interpretation. Each indicator report also compares management actions each tenure holder has taken relevant to an indicator.

5.2.1 – Indicator: Area of suitable habitat for Newfoundland Marten

Interview subjects who selected the indicator "Area of suitable habitat for selected species (including consideration of factors such as connectivity, fragmentation and existence of features such as snags, coarse woody debris, etc.)", were asked to select a species that would be appropriate for study. All interview subjects suggested Newfoundland Marten, whose

Newfoundland population is listed as *endangered* under the provincial Endangered Species Act (2001) and federal Species at Risk Act (2002).

Though once found throughout forested areas of the Island of Newfoundland, the majority of their population is now located in Western Newfoundland. The total population of Newfoundland Marten on the Island of Newfoundland is approximately 300 individuals. Their decline has been attributed to habitat loss due to logging and fire, excessive trapping, and accidental captures in traps and snares set for other species (Government of Canada, n.d.). Government of Canada (n.d.) also states, "Logging continues to be a major threat in most of the remaining marten habitat."

An Eastern Newfoundland population of Newfoundland Marten is located in Terra Nova National Park and surrounding forest region, including a portion of Forest Management District 4. Approximately 25-30 individuals are known to exist in the Terra Nova National Park region (Gosse *et al.* 2005).

Measurement methods:

The indicator has not been designed to provide information on the interaction of forest property rights and area of suitable marten habitat. For the purposes of this thesis, therefore, measures are proposed which reference the management actions of each tenure holder with respect to maintenance of suitable marten habitat, and measure the area of suitable habitat by tenure holder:

Measure 1: A comparative review of management actions of each tenure holder in relation to Newfoundland Marten has been made.

Measure 2: GIS analysis was undertaken to determine the relative area of suitable marten habitat in relation to total managed forest area for each tenure holder.

Reference values:

Measure 1: The management actions of each of the three tenure holders are compared against one another.

Measure 2: Recovery planning for the Eastern Newfoundland population of Newfoundland Marten, a process that all three tenure holders participate in, targets the establishment of a population of at least 50 animals (Government of Newfoundland and Labrador 2000a). No specific targets have been set, however, concerning the total area of suitable habitat required to sustain 50 animals.

The Eastern population of Newfoundland Marten, like other North American populations, prefer productive stands, as opposed to lower volume scrub forest or non-forested areas[15] (Gosse *et al.* 2005). As total productive forest area of each tenure holder in the study area varies, the potential amount of suitable marten habitat which a tenure holder might sustain will also vary. To facilitate comparison, measures are made which calculate the amount of suitable habitat in relation to total productive managed forest area of each tenure holder.

Results and Interpretation:

Measure 1. Comparison of management actions by tenure holder

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[15] Gosse *et al.* (2000) recommend further study of Newfoundland Marten activity to determine if scrub forest is suitable for denning and foraging, or if its use is strictly limited to dispersal between more productive forest patches.

Table 10 summarizes the management actions of each tenure holder.

Table 10: Summary of management actions affecting marten habitat by tenure holder

Management actions affecting marten habitat within study area	CBPP	ACCC	Crown
1. Participate in Newfoundland Marten recovery planning	Yes	Yes	Yes
2. Consult with Wildlife Division on the preparation and design of harvesting plans	Yes	Yes	Yes
3. Set specific targets in management plans for the maintenance of marten habitat	Yes – maintain current marten habitat within a +/- 20% level†.	No	No
4. Have classified forest areas within the study area as "alienated" for the purposes of marten habitat protection.	No*	Yes – 1732 hectares (156 ha. in FMD 4 and 1576 ha. in FMD 5)*.	Yes – 973 hectares in FMD 5*.

† CBPP (2004).
*Newfoundland Forest Stand Inventory (2002).

As summarized in Table 10, the management actions of each of the three tenure holders in response to Newfoundland Marten habitat requirements is similar. Each tenure holder participates in the ongoing work of the Newfoundland Marten Recovery Team, a formal body that is preparing a consensus-based Recovery Plan and Action Plan for the marten, as required under federal and provincial endangered species legislation. Each tenure holder consults with the Department of Environment and Conservation's Wildlife Division in the preparation of forest operating plans.

Only CBPP has explicitly targeted a quantity of marten habitat to be maintained (+/- 20% of current levels) on their landbase. The significant difference, however, in management actions concerns the amount of land that has been classified as alienated from cutting, for the purposes of marten habitat maintenance. ACCC has alienated the largest amount of land (1732 hectares), followed by the Crown (973 hectares), while CBPP has alienated no land. The land alienated for marten protection is located predominantly in the southeast corner of FMD 5, adjacent to Terra Nova National Park. The Crown forest manager downplayed the difference in area of land alienated stating, "I would suggest this were put there because there was no activity there, so it was an easy thing to do." Furthermore, they explained that this alienation is temporary in nature.

Measure 2. GIS analysis of suitable marten habitat by tenure holder

Wildlife Division provided a sample suitable habitat map for Newfoundland Marten in the study area (see Appendix 4), based on the Marten Model Output Version 4.5 (Wildlife Division 2005)[16]. The Marten Model identifies suitable habitat based on forest height class, stand type, proximity and contiguity of habitat patches, and marten home range zones.

Approximately 69,915 hectares of suitable marten habitat are present within the study area, distributed according to Figure 11 and Table 11.

[16] The map is referred to as a "sample" suitable habitat map for Newfoundland Marten as the model is being continually updated and revised as new research becomes available.

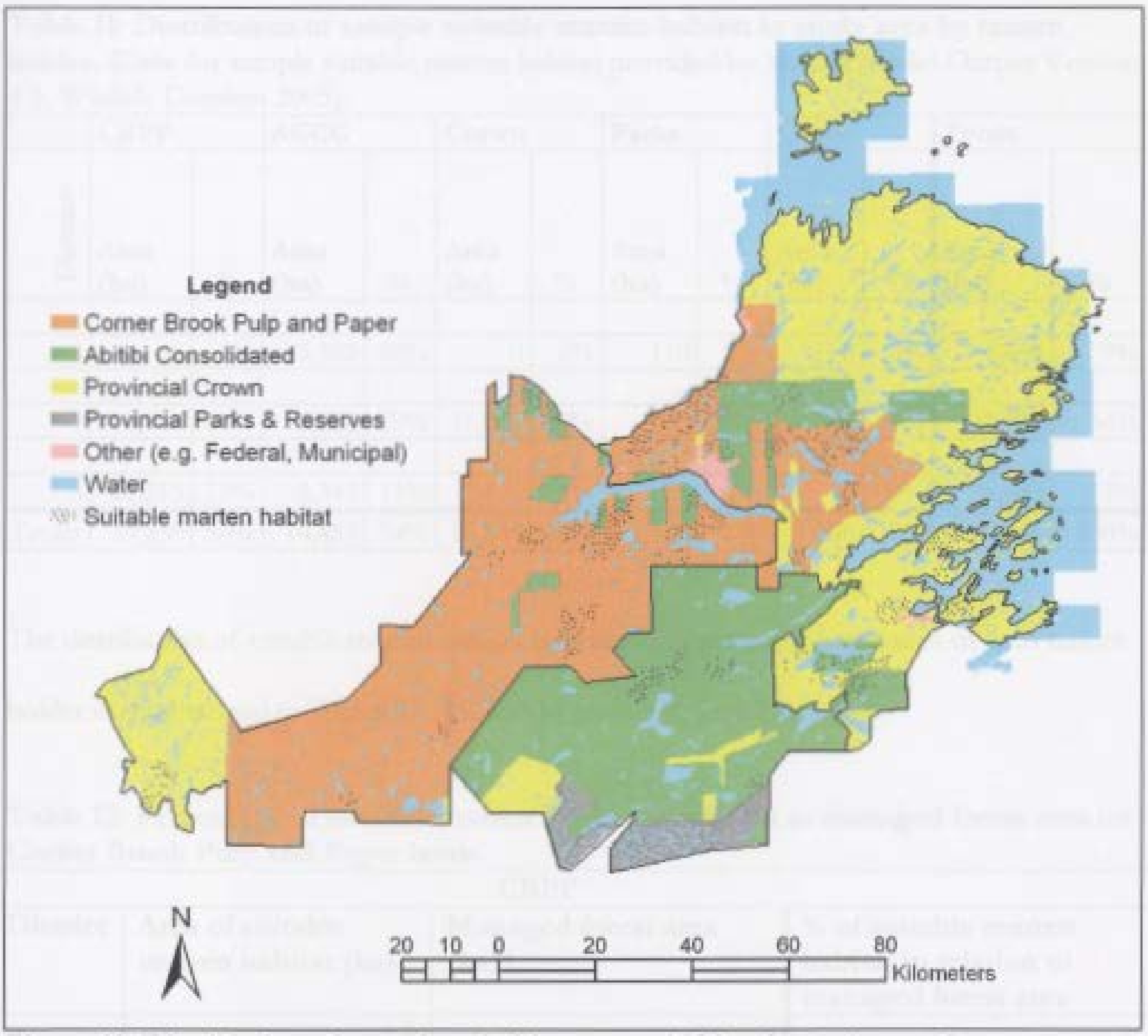

Figure 11: Distribution of sample suitable marten habitat in study area by tenure holder. (Data for sample suitable marten habitat provided by Marten Model Output Version 4.5, Wildlife Division 2005).

Table 11: Distribution of sample suitable marten habitat in study area by tenure holder. (Data for sample suitable marten habitat provided by Marten Model Output Version 4.5, Wildlife Division 2005).

	CBPP		ACCC		Crown		Parks		Other		Totals	
District	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
4	0	0%	5,853	98%	0	0%	110	2%	0	0%	5,963	9%
5	19,017	50%	7,283	19%	11,061	29%	202	1%	306	1%	37,870	54%
6	20,213	77%	3,347	13%	2,470	9%	53	0%	0	0%	26,083	37%
Totals	39,230	56%	16,483	24%	13,531	19%	365	1%	306	0%	69,915	100%

The distribution of suitable marten habitat in relation to managed forest area of each tenure holder is summarized in Tables 12, 13, and 14 and in Figures 12 and 13.

Table 12: Percentage of suitable marten habitat in relation to managed forest area on Corner Brook Pulp and Paper lands

CBPP			
District	**Area of suitable marten habitat (ha)**	**Managed forest area (ha)***	**% of suitable marten habitat in relation to managed forest area**
4	0	0	--
5	19,017	57,426	33%
6	20,213	148,944	14%
Totals	39,230	206,370	19%

*Includes productive, silviculture, cutover, natural disturbance, and alienated land classes.

Table 13: Percentage of suitable marten habitat in relation to managed forest area on Abitibi Consolidated Company of Canada lands

ACCC			
District	**Area of suitable marten habitat (ha)**	**Managed forest area (ha)***	**% of suitable marten habitat in relation to managed forest area**
4	5,853	82,982	7%
5	7,283	28,879	25%
6	3,347	12,074	28%
Totals	16,483	123,935	13%

*Includes productive, silviculture, cutover, natural disturbance, and alienated land classes.

Table 14: Percentage of suitable marten habitat in relation to managed forest area on Crown lands

	Crown		
District	Area of suitable marten habitat (ha)	Managed forest area (ha)*	% of suitable marten habitat in relation to managed forest area
4	0	2,378	0%
5	11,061	113,164	10%
6	2,470	8,757	28%
Totals	13,531	124,299	11%

*Includes productive, silviculture, cutover, natural disturbance, and alienated land classes.

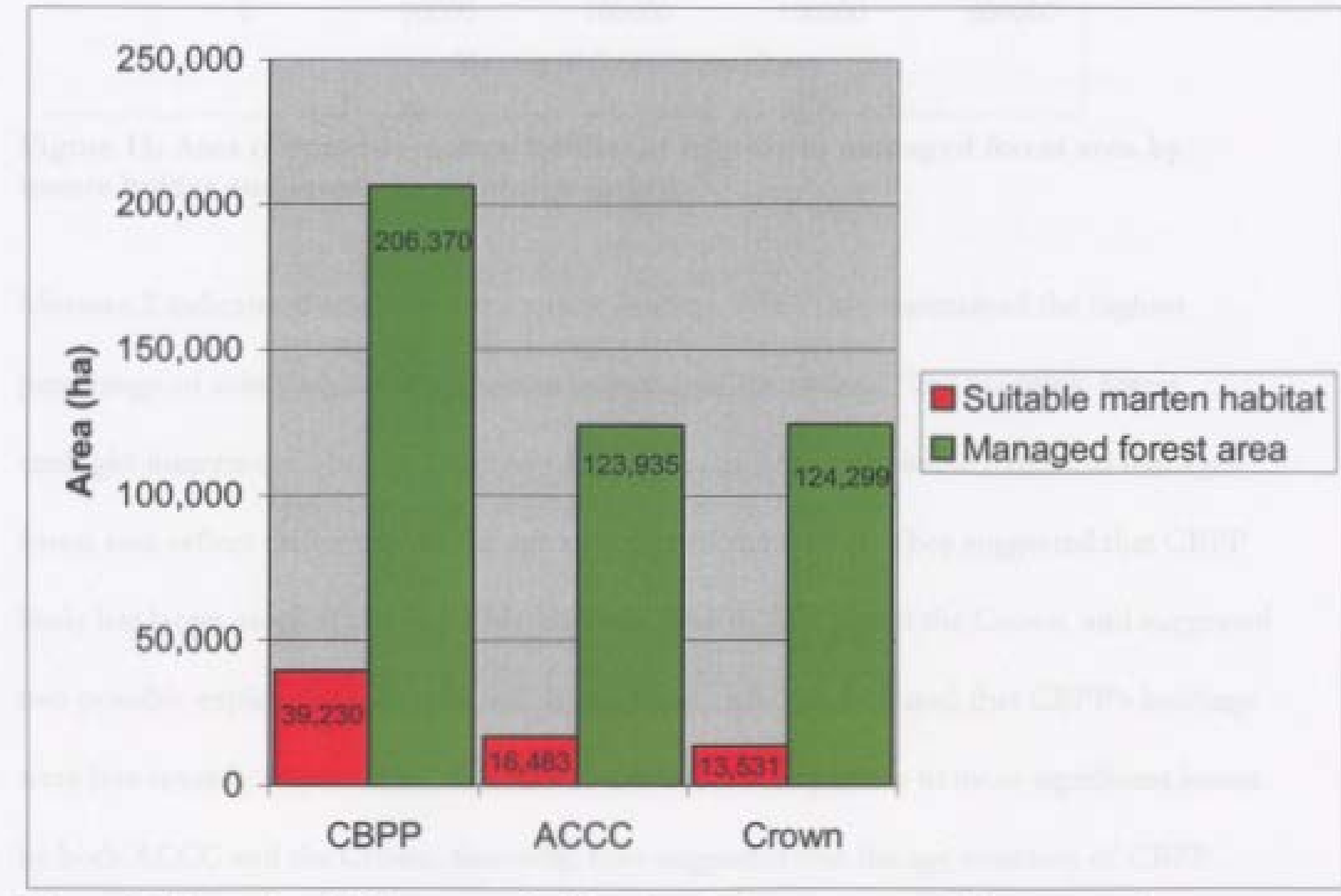

Figure 12: Area of suitable marten habitat in relation to managed forest area by tenure holder

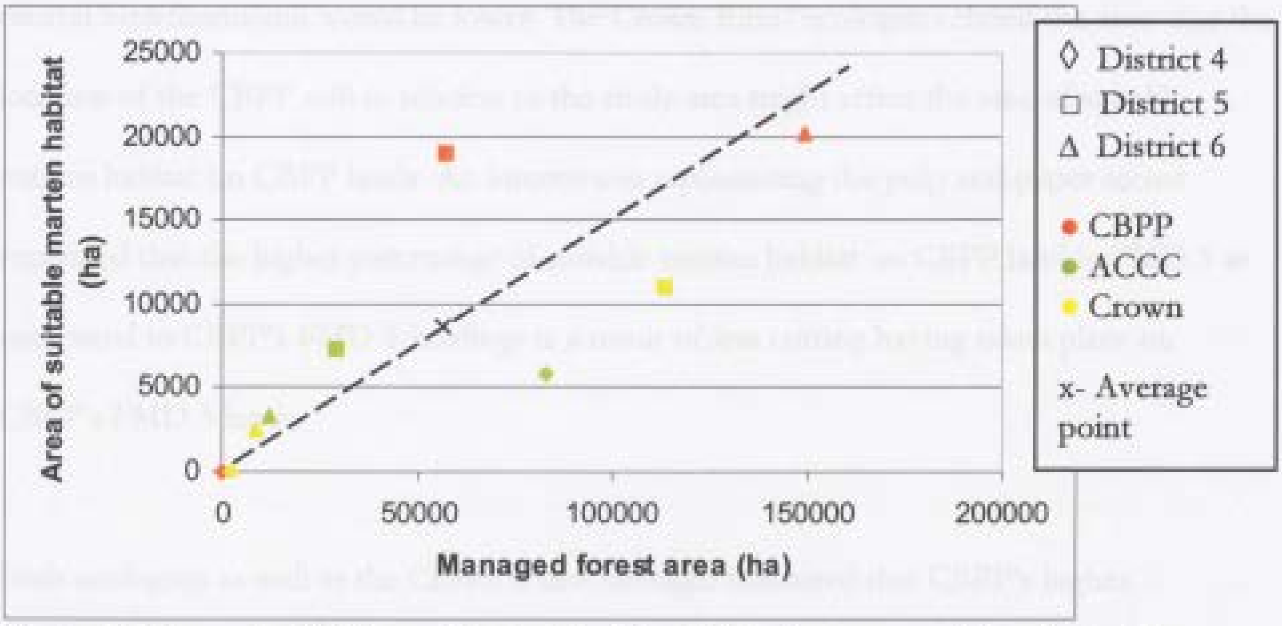

Figure 13: Area of suitable marten habitat in relation to managed forest area by tenure holder and forest management district

Measure 2 indicates that of the three tenure holders, CBPP has maintained the highest percentage of suitable habitat in relation to managed forest area. The academic forest ecologist interviewee observed that any differences in ratios of suitable habitat to managed forest area reflect differences in the age structure of the forests. They suggested that CBPP likely has larger areas of old forest stands compared to ACCC and the Crown, and suggested two possible explanations for this difference. First, they hypothesized that CBPP's holdings were less severely impacted by the 1961 forest fire, in comparison to more significant losses by both ACCC and the Crown. Secondly, they suggested that the age structure of CBPP forests might be older (thereby producing more suitable habitat for marten), due to a shorter history of cutting and a slower rate of cutting on CBPP lands, particularly when compared to the history of cutting on ACCC lands in the study area. They also noted that lower pressure on CBPP lands might be a function of the long distance and hence high costs of transportation from the eastern region of Newfoundland to CBPP's paper mill on the west coast. In comparison, ACCC's costs of shipping wood from this region to their mill in central Newfoundland would be lower. The Crown forest ecologist echoed the view that the location of the CBPP mill in relation to the study area might affect the area of suitable marten habitat on CBPP lands. An interviewee representing the pulp and paper sector explained that the higher percentage of suitable marten habitat on CBPP land in FMD 5 as compared to CBPP's FMD 6 holdings is a result of less cutting having taken place on CBPP's FMD 5 lands.

Both ecologists as well as the Crown forest manager theorized that CBPP's higher percentage of suitable marten habitat could also be attributed to differences in forest site conditions between the three tenure holders. The academic forest ecologist commented that Balsam Fir dominated forest tends to reach older ages than Black Spruce dominated forests. They suggested that CBPP has the richest forested sites in the study area in the Gander Lake Watershed and Gambo Pond areas, and likely have comparatively higher concentrations of Balsam Fir dominant stands than ACCC or the Crown. They explained that ACCC's holdings in the Terra Nova Watershed of FMD 4 are "all Black Spruce which is more prone to burn, and that's why it's left out of the marten habitat model." The Crown forest manager pointed to the influence of forest site condition by noting that CBPP's forests in FMD 5 are "well-forested, and fairly productive," while by contrast ACCC's land in FDM 4, is "a much more fragmented landscape."

Though the CBPP total (19%) is nearly twice as high than the Crown (11%), it should be noted that a portion of the productive Crown forest is located in the north-western portion of the study area in District 5, including Fogo Island, isolated from suitable marten habitat areas of the interior portions of the study area. Given that the marten habitat suitability model takes into account the proximity and contiguity of habitat patches, suitable forest stands within this area of productive Crown forest would have been discounted as suitable habitat areas. The academic forest ecologist and Crown forest manager also attributed the low Crown percentage to the influence of the 1961 fire, which has reduced the relative amount of old age class forest.

As noted in the results of the scoping phase interviews, a Crown forest manager predicted that tenure can have a direct impact on habitat for sensitive species such as marten in cases where small tenure blocks limit the manoeuvrability of the tenure holder in designing their cutting plans. The small size of some tenure blocks within the study area (in particular on ACCC lands in FMD 6) does not appear to have a significant influence on the amount of suitable marten habitat. In fact, for all three tenure holders across each of the management districts, the percentage of suitable marten habitat in relation to total managed forest area increases with decreasing size of the total managed forest area. The exception is Crown land in FMD 4.

5.2.2 – Indicator: Area of each forest type by age class

Forest succession is an ecological process that can be examined at a landscape scale to understand forest condition. Two of the key variables in assessing differences in succession between selected forest areas are age-class structure and tree species composition (Haeussler and Kneeshaw 2003).

Measurement methods:

Measure 1: A comparative review of management actions of each tenure holder in relation to area of each forest type by age class has been made.

Measure 2: Measures of distribution of forest types are presented for each tenure holder, and are grouped by management district.

Measure 3: Measures of age class structure are presented for each tenure holder, and are grouped by management district.

Analysis of area of each forest type by age class within the study area was carried out on forest lands classified as "productive" and "alienated" in the *Newfoundland Forest Stand Inventory* (NFSI) (2002). Productive class forests are stands deemed to be commercially viable and available for cutting[17]. Alienated stands include buffer areas, stands which are uneconomical to log, special wildlife habitat areas, wildlife reserves, and candidate ecological reserves. Other forest classes in the NFSI (2002) such as "silviculture", "cutovers" and "disturbed" were not included in the analysis as these data fields contain out-of-date age class and species type data. Forest classed as "scrub" was not included in the analysis as the NFSI (2002) does not assign age or species identification to these non-commercially viable stands, though scrub forests are of ecological value.

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[17] See Note 2, Page 8.

Reference values:

Measure 1: The management approaches of each of the three tenure holders are compared against one another.

Measures 2 and 3: In the first round of interviews the academic forest management expert recommended that indicators be interpreted in the context of what happens under "normal circumstances" in an unmanaged forest, and compared to what happens in a forest management scenario.

The "natural disturbance model" endorses the emulation of natural processes and patterns as guidelines for the conservation of biodiversity, and provides one approach to setting baseline references in forest sustainability monitoring (Adamowicz and Burton 2003). Understanding the natural disturbance history of a given forest ecosystem under "natural", unmanaged conditions, is the starting point for developing a management regime which emulates natural processes.

Terra Nova National Park (TNNP), which borders the study area to the south-east of District 5 (see Figure 14), is used in the analysis as a comparative reference for forest cover and age class distribution in an ecologically similar forest where logging is prohibited[18]. Situated predominantly within the Northcentral Subregion (IIA), with coastal areas located

[18] Guidelines for vegetation management within Terra Nova National Park include "maintenance of ecosystem structure and function ... realised through disturbance management by maintaining or restoring dynamic elements and ecosystem processes within the range of natural variability" (Power 2000, 4). Given a long history of exotic herbivory and fire suppression in the region, as well as logging activity within park boundaries prior to park establishment, current forest composition should not be viewed as characteristic of a natural, unaltered forest.

in the North Shore Forest Ecoregion (III), TNNP is located in a region ecologically similar to the study area.

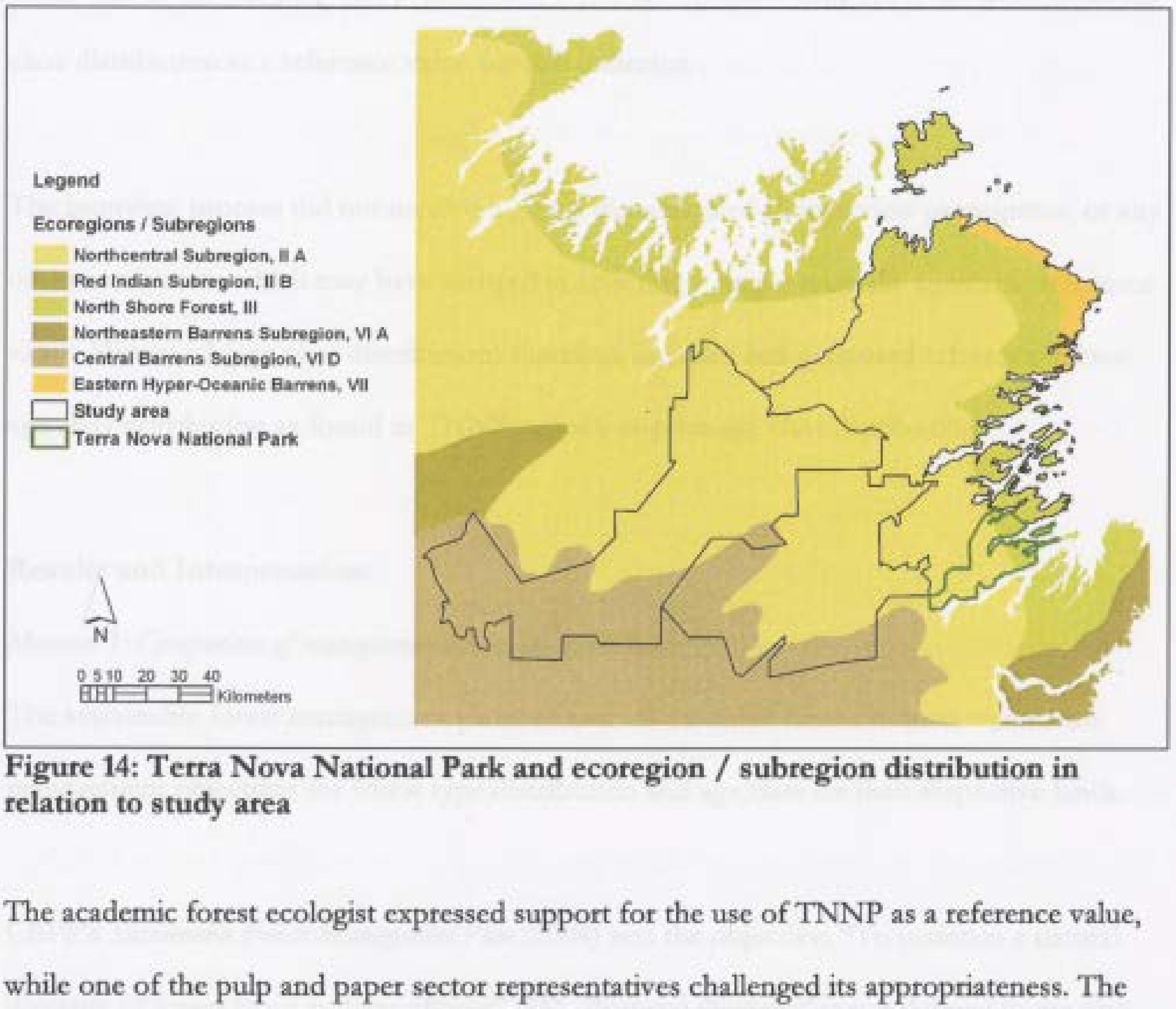

Figure 14: Terra Nova National Park and ecoregion / subregion distribution in relation to study area

The academic forest ecologist expressed support for the use of TNNP as a reference value, while one of the pulp and paper sector representatives challenged its appropriateness. The latter argued that the more appropriate reference value for a forest managed for timber production is an even-age class structure, as opposed to the age-class structure found within a park. They explained that once an even-age class distribution is attained, the annual allowable cut will reach its highest possible level, and as such is the desired future condition of the forest. As well, they explained that even-age classed forests can also have benefits for many wildlife species, including Newfoundland Marten. Western Newfoundland's FMD 15, they cited, is one of the districts which has been most heavily impacted by logging activity, and is closest to achieving a balanced age class distribution, while at the same time has maintained higher numbers of Newfoundland Marten than many other management districts. The second pulp and paper sector representative also supported use of an even-age class distribution as a reference value for this indicator.

The interview process did not involve a group discussion of all interview participants, or any other mechanism which may have assisted in selecting a single, mutually agreeable reference value. Measure 3 (age class distribution) therefore includes *both* proposed reference values: age class distribution as found in TNNP, as well as even-age class distribution.

Results and Interpretation:

Measure 1: Comparison of management actions by tenure holder

The sustainable forest management plans of each of the three tenure holders outline the management objectives for forest type distribution and age class on their respective lands.

CBPP's *Sustainable Forest Management Plan* (2004) sets the objective: "To maintain a natural diversity of forest types and age classes" (21). "Natural diversity" is not defined in the plan however. The same document identifies the target: "To maintain representation (by area) of current working group classes close to current levels" (21). Major working groups such as Balsam Fir and Black Spruce are targeted to be maintained within +/- 10% of current levels.[19]

[19] These statements suggest that CBPP assumes that "current levels" of working group diversity and age-class structure represent the "natural diversity of forest types and age classes".

ACCC's *Sustainable Forest Management Plan 2001-2021* (2001) sets a management target of a regulated, even age-class forest structure, with a minimum of 15% representation of each forest age class across their managed forest area. ACCC employs this management approach as it will "... accomplish a maximum sustainable harvest and allow for other uses of the forest" (ACCC 2001, 44). This plan does not set a target for desired forest cover distribution.

The latest version of the Crown's *Provincial Sustainable Forest Management Strategy* (2003) does not set any specific targets for desired age class structure or forest cover distribution on a landscape scale[20]. It does however target the maintenance of 15-20% of forests in the province as old forest. As well, it sets a goal to "maintain the natural processes of forest ecosystems within the province", (53) and aims to "implement harvesting guidelines that emulate natural disturbance regimes in the province" (54)[21]. The plan also sets goals to maintain or restore natural tree species composition through reforestation of White Pine and Red Pine, as well as planting of Black Spruce on Black Spruce-origin sites that have become stocked with Balsam Fir.

The Crown's (2003) goal of "maintaining natural processes" and CBPP's (2004) objective of "maintaining a natural diversity of forest types and age classes", suggest that their management approach differs from that of an even-age forest, as targeted by ACCC. But it

[20] It should be noted however that previous versions of the Crown's plan (Government of Newfoundland and Labrador 1996a) targeted the establishment of a balanced age class structure.

[21] The plan does not acknowledge that the goals of maintaining 15-20% of forests as old forests, while also maintaining the "natural processes of forest ecosystems", and emulating "natural disturbance regimes" may conflict.

should be acknowledged that all three tenure holders are governed by the *Forestry Act* (1990), which requires "sustained yield forest management", defined as a "policy, method or plan of management to provide for an optimum continuous supply of timber in a manner consistent with other resource management objectives…". Such a management approach is usually associated with creation of a regulated, even-aged forest. As one of the pulp and paper sector representatives pointed out, the *2006 Island Wood Supply Analysis* (Government of Newfoundland and Labrador 2006) which is used to generate Annual Allowable Cut calculations for each tenure holder is modelled on reducing the amount of old forest (which currently compose approximately 37% of Newfoundland forests (Government of Newfoundland and Labrador 2003)) to a minimum of 15%. The logging strategy of all three tenure holders prioritizes cutting "oldest first", in an effort to reduce the ratio of 80+ aged stands, and move towards a balanced age class distribution. Though the sustainable forest management plans of CBPP and the Crown do not state that even-age class distribution is their management goal, interpreting those plans in the context of the *Forestry Act* (1990) and the *2006 Island Wood Supply Analysis* (Government of Newfoundland and Labrador 2006) reveal that it in fact is.

Measure 2: Distribution of forest types

An ecological forest site typing of the study area has never been carried out. A forest site type map would indicate what types of tree and plant communities a specific site is capable of having. Such a map would therefore provide a baseline reference for understanding forest type distribution under natural conditions within the area, and changes to that distribution due to natural disturbances (e.g. fire) and non-natural disturbances (e.g. logging activity).

In the absence of a forest site type map, eight different forest working groups[22], drawn from the NFSI (2002), were used to assess the distribution of forest types: Balsam Fir, Black Spruce, Hardwood-Softwood mixed, Softwood-Hardwood mixed, White Birch, Trembling Aspen, Disturbed, and Not stocked. The distributions of forest working groups for each tenure holder are listed in Tables 15, 16 and 17.

Table 15: Distribution of forest working groups by Forest Management District within Corner Brook Pulp and Paper tenured area

CBBP	FMD 4		FMD 5		FMD 6		TOTALS	
Working group	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Balsam Fir	0	0%	2,304	5%	13,292	10%	15,596	9%
Black Spruce	0	0%	28,714	62%	100,361	77%	129,075	73%
Hardwood – Softwood mixed	0	0%	3,168	7%	2,738	2%	5,907	3%
Softwood – Hardwood mixed	0	0%	3,821	8%	6,249	5%	10,070	6%
White Birch	0	0%	3,692	8%	3,019	2%	6,711	4%
Trembling Aspen	0	0%	73	<1%	94	<1%	167	<1%
Disturbed	0	0%	66	<1%	582	<1%	648	<1%
Not stocked	0	0%	4,737	10%	4,556	3%	9,293	5%
TOTALS	0	0%	46,575	100%	130,892	100%	177,468	100%

[22] See detailed explanation of forest working groups on p. 45.

Table 16: Distribution of forest working groups by Forest Management District within Abitibi Consolidated Company of Canada tenured area

ACCC	FMD 4		FMD 5		FMD 6		TOTALS	
Working group	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Balsam Fir	5,187	7%	1,151	5%	738	6%	7,076	7%
Black Spruce	57,040	81%	14,954	66%	7,951	69%	79,945	77%
Hardwood – Softwood mixed	1,091	2%	961	4%	839	7%	2,891	3%
Softwood – Hardwood mixed	1,553	2%	2,065	9%	1,180	10%	4,798	5%
White Birch	979	1%	601	3%	384	3%	1,963	2%
Trembling Aspen	25	<1%	12	<1%	24	<1%	60	<1%
Disturbed	581	1%	138	1%	33	<1%	751	1%
Not stocked	3,757	5%	2,631	12%	361	3%	6,749	6%
TOTALS	70,245	100%	22,511	100%	11,509	100%	104,265	100%

Table 17: Distribution of forest working groups by Forest Management District within Crown tenured area

CROWN	FMD 4		FMD 5		FMD 6		TOTALS	
Working group	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Balsam Fir	95	4%	7,747	8%	67	1%	7,909	8%
Black Spruce	2,144	94%	54,844	59%	7,742	89%	64,730	62%
Hardwood – Softwood mixed	8	<1%	8,627	9%	282	3%	8,917	9%
Softwood – Hardwood mixed	6	<1%	16,338	18%	543	6%	16,886	16%
White Birch	1	<1%	2,898	3%	59	1%	2,959	3%
Trembling Aspen	0	0%	208	<1%	3	<1%	211	<1%
Disturbed	0	0%	14	<1%	0	0%	14	<1%
Not stocked	37	2%	2,595	3%	25	<1%	2,657	3%
TOTALS	2,291	100%	93,271	100%	8,721	100%	104,750	100%

Forest site type classification (following Damman 1964, and Meades and Moores 1994) in the adjacent TNNP indicates that Black Spruce forest types should compose about 81% of the park area, Balsam Fir types about 14%, Hardwood types about 4%, other forest types less than 1%. If the distribution of forest site types within TNNP is assumed comparable to forest site types that should be found within the study area, it appears that tenure holders within FMD 4 have maintained a natural distribution of forest site types. In contrast, FMD 5 appears to have the most severe discrepancies from TNNP reference values. Crown forests have a high percentage of Softwood-hardwood mixed and Hardwood-softwood mixed forests. Examining the totals from all three management districts, Softwood-hardwood mixed forest is 10%-11% higher in Crown forests than on company-tenured areas. Hardwood-softwood mixed forest is 6% higher on Crown forests than on company-tenured areas.

The academic forest ecologist explained that mixed forests arise following logging in a management regime of active fire suppression. They suggested that the higher percentage of hardwood species on Crown land found in mixed stands is also likely a result of different cutting objectives of the Crown and the two companies. The companies manage their forests more exclusively towards softwood regeneration by hiring fuelwood cutters to target only hardwood species on cutovers, while leaving softwood regeneration. On Crown lands, they explained, "the same domestic cutters … will obviously cut softwood cause there's more heat in a softwood log." The Crown forest manager and one of the pulp and paper sector representatives explained the higher proportions of mixed stands as on Crown lands as a result of the 1961 fire. Both Trembling Aspen and White Birch have established following that fire event.

Power's (2000) analysis of forest site type distribution in TNNP provides some clues to explain the higher proportion of hardwood species types on Crown lands within the study area. Power (2000) describes a higher than normal presence of Balsam Fir types and hardwood species, specifically the Birch-Aspen (BtA) forest type, within TNNP. Power (2000) suggests that historic logging activity, prior to the creation of the park, has produced a greater area occupied by Balsam Fir types than would normally occur in a fire-driven ecosystem. The correlation between pre-park logging and presence of Balsam Fir is particularly marked in coastal areas, presumably due to their proximity to communities. Decreased fire events over the last century have allowed Balsam Fir to persist. BtA forest is one successional type that occurs when there is insufficient Balsam Fir seed supply or a low abundance of advance fir regeneration. Intense Moose (and possibly Snowshoe Hare) browsing have severely limited the regeneration of Balsam Fir in TNNP, thereby resulting in an increased presence of BtA forest type (Power 2000). Successional paths similar to those described by Power (2000) may be present on Crown land in District 5.

It is also noteworthy that Black Spruce percentages for all three tenure holders are lowest in District 5. Both Crown at 59%, and CBPP at 62%, are well below the TNNP reference point of 81% Black Spruce forest site types. The possible causes of reduced Black Spruce coverage within District 5 are logging activity and low-intensity fires. Clear-cutting a Black Spruce forest type on a medium to low nutrient site can produce the Kalmia Black Spruce forest type, particularly where Balsam Fir is rare. Low-intensity fires can convert the Kalmia Black Spruce forest type into Kalmia heath (Damman 1983, Meades and Moores 1994, Power 2000). Both of these factors have likely influenced the establishment of lower proportions of Black Spruce in District 5, in comparison to Districts 4 and 6. The Bonavista North

Peninsula, which defines District 5, has a longer history of settlement compared to the interior Districts 4 and 6, and in turn, a longer history logging activity. As well, District 5 was more severely affected by the 1961 burn than Districts 4 and 6.

Commenting on CBPP tenure lands, one of the pulp and paper sector representatives explained that Black Spruce compose approximately 38% of the company's forest across the Island. CBPP wants to maintain that level of Black Spruce, as their "recipe" for making paper includes 35% Black Spruce. They explained that this recipe was created following a survey of tree species distribution on CBPP lands.

Measure 3: Age class structure

Power's (1996, 2000) age class analysis of all stand types in TNNP reveals a range of tree ages from 39 – 220 years old (see Figure 15). The majority (70%) of stand types are in the 120-150 year classes, and approximately 85% of the park forests are 70 years or older. The mean stand age is 98 years (Power 1996, 2000).

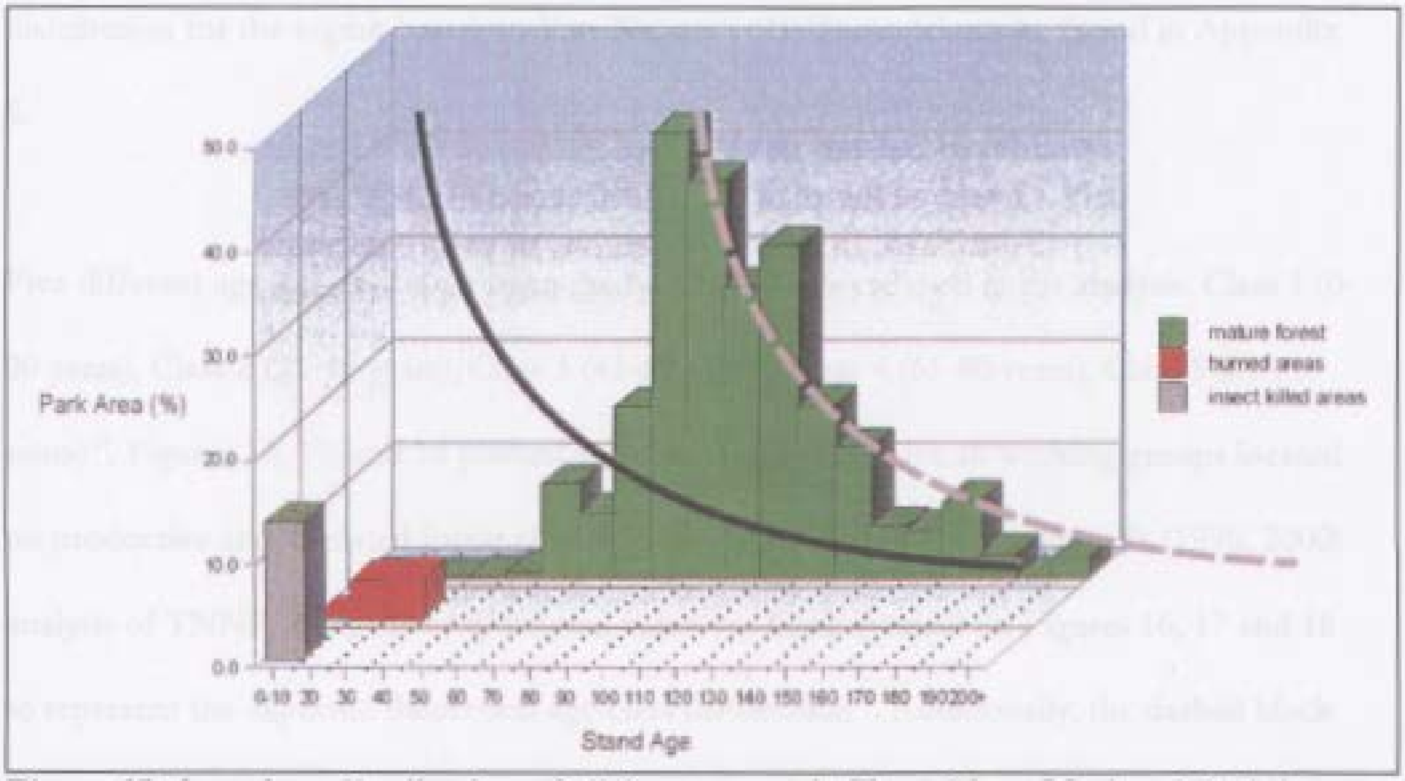

Figure 15: Age class distribution of all forest types in Terra Nova National Park in relation to theoretical age class distribution (black curve) for fire-dependent ecosystems (Source: Power 2000, 30).

Power (1996, 2000) notes that the present age class distribution in TNNP varies from the theoretical stand distribution for fire dependent ecosystems (black curve, Figure 15) (Van Wagner 1978). Nevertheless, the present age class distribution reveals that the expected theoretical distribution did exist 110 years ago, as indicated by the dashed grey line (Power 1996, 2000). Power (2000) concludes that a "distinct change in stand age distribution approximately 80 years ago reveals that stand replacement fire has not occurred at the rate that it has in the past" (30). Power (1996, 2000) attributes this change to increased fire detection and suppression capabilities over the past century. The expected age class distribution for the forests of this region under "natural conditions" (as indicated by the black curve, Figure 15), consists of approximately 63% of stands between 0-79 years of age, and 37% of stands aged from 80- 200 years. A detailed summary of the expected age class distribution for the region based on Van Wagner's (1978) model can be found in Appendix 5.

Five different age classes, drawn from the NFSI (2002), were used in the analysis: Class 1 (0-20 years), Class 2 (21-40 years), Class 3 (41-60 years), Class 4 (61-80 years), Class 5 (81+ years)[23]. Figures 16, 17, and 18 present age class distributions for all working groups located on productive and alienated forest classes by tenure holder. Following Power's (1996, 2000) analysis of TNNP, a negative exponential curve has been overlaid on Figures 16, 17 and 18 to represent the expected theoretical age-class distribution[24]. Additionally, the dashed black line represents a second reference value of even-age class distribution.

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[23] Ideally, the analysis would be carried out using more refined age class divisions (e.g. of five- or ten-year increments), so that any subtle differences in the age class structure in the forests of different tenure holders could be detected. This was not possible however, as the NFSI (2002) does not assign forest stands an age of origin.

[24] This comparison assumes that the fire regime in the study area is identical to that of TNNP.

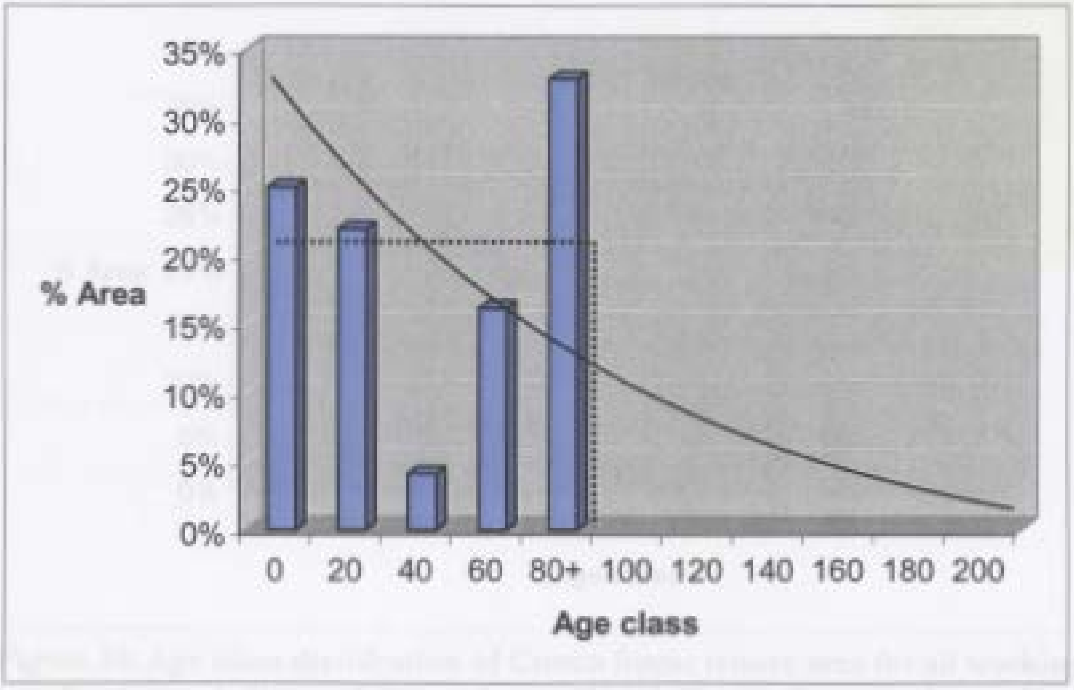


Figure 16: Age class distribution of Corner Brook Pulp and Paper forest tenure area for all working groups (productive and alienated forest classes) in relation to theoretical age class distribution (black curve), and even-age class distribution (dashed line).

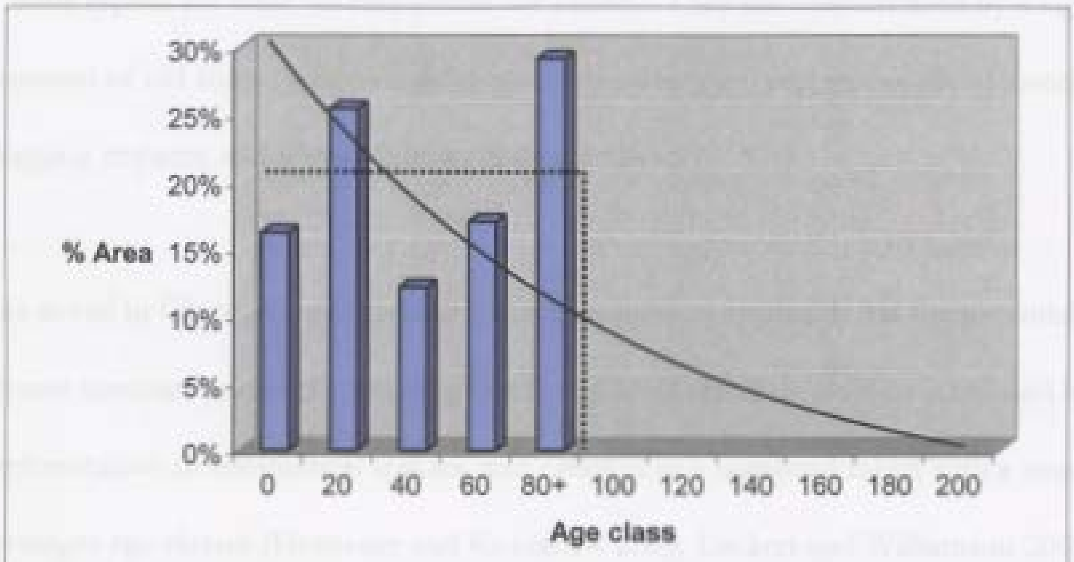


Figure 17: Age class distribution of Abitibi Consolidated Company of Canada forest tenure area for all working groups (productive and alienated forest classes) in relation to theoretical age class distribution (black curve), and even-age class distribution (dashed line).

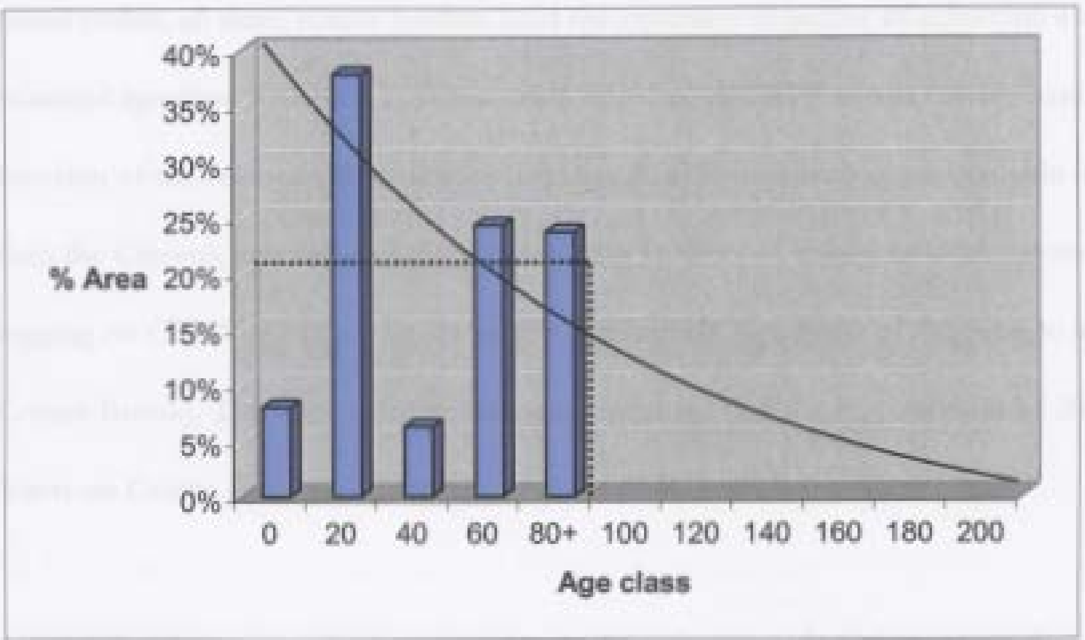


Figure 18: Age class distribution of Crown forest tenure area for all working groups (productive and alienated forest classes) in relation to theoretical age class distribution (black curve), and even-age class distribution (dashed line).

The Crown forest manager described the CBPP and ACCC age class distributions as being "fairly typical for what we find across the Island." They are characterized by a significant amount of old forest; a significant amount regenerating forest as a result of insect, fire and logging impacts; and a weak intermediate age class.

As noted in Chapter 2, a Sustained Yield Management approach has the potential to alter forest structure across the landscape such that biodiversity is ultimately reduced by reforestation to commercial species, and creation of a regulated forest with a trend towards younger age-classes (Haeussler and Kneeshaw 2003, Luckert and Williamson 2005). None of the forest tenure holders has maintained the ratio of older forests at the theoretical natural level (approximately 37%) as determined by the Van Wagner (1978) model. CBPP has maintained the highest proportion of old forests (approximately 33% in the 80+ class), while at approximately 23%, the lowest proportion of old forests is found on Crown lands. As noted earlier, all three tenure holders hold the common objective of achieving a regulated, balanced age class structure. Differences in impacts on CBPP versus Crown land may be a function of the relative size of tenure holdings (CBPP has much more available forest lands than the Crown), and distance from processing facilities of tenure holders (intensity of logging on CBPP lands may be lower due to relatively high costs of shipping to its mill in Corner Brook). The Crown forest manager explained that the high amount of 20-40 year old forest on Crown land can be explained by the 1961 fire.

ACCC's holdings most closely approximate the reference value of even-age class distribution. Like CBPP and the Crown, ACCC has a deficit of stands in the 40-60 age class, a characteristic of productive forests across the Island. The Crown has a deficit of young regenerating forest (age class 0-20 years).

The age class structure of each working group (Balsam Fir, Black Spruce, etc.) by tenure holder is presented in Appendices 6, 7, and 8. Analysis of age class distribution by tree species type within the study area indicates more similarities than differences amongst each of the three tenure holders. One difference however is that only Crown forests include stands of age class 9 (mixed-age stands). The academic forest ecologist and Crown forest manager explained that the presence of age class 9 stands on Crown lands is a result of domestic cutting practices. Domestic cutters tend to cut selectively, producing stands of mixed age, while the companies employ clear-cut practices, producing even-aged stands.

Older classes (4 and 5) of Balsam Fir are in low quantity across all three tenure holders. These classes make up 16% of Crown forests, 10% of ACCC forests, and only 1% of CBPP forests. Both pulp and paper sector representatives explained the low percentages of older class Balsam Fir as a result of a Hemlock Looper outbreak in the late 1970s and early 1980s. One of them noted that it was particularly severe in the Home Pond and Soulis Pond area of District 5 (see Appendix 2).

5.2.3 – Indicator: Proportion of each ecoregion that is in a protected status

The provincial Department of Environment and Conservation's protected areas strategy aims to establish a network of protected areas representative of each ecoregion and subregion in the province (Government of Newfoundland and Labrador 2000c).

Measurement methods:

The *State of the Forest Report* (WNMF 2000) proposes to measure this indicator by tracking protected area designation over time, for those ecoregions and subregions which overlap their study area (the Western Newfoundland Model Forest region). Though informative on an ecoregion scale, such a measure would provide no information on the interaction of forest property rights and protected area designation within the study area. The boundaries of the study area (forest management districts 4, 5, and 6) do not correspond to ecoregion boundaries. Portions of the Northcentral Subregion, North Shore forest Ecoregion, Central Barrens Subregion, and Eastern Hyper-Oceanic Barrens Ecoregion are located both inside and outside the study area. A measure scaled at an ecoregion level will therefore report on protected areas that potentially fall outside the study area.

The Crown forest ecologist commented that the WNMF (1999) definition of a protected area as "an area with legislated restrictions to limit human impact, including prohibitions on logging, hydroelectric developments and mineral or hydrocarbon exploration and development" (17) might in fact be too narrow in scope. Logging is sometimes prohibited (and lands are therefore protected) by other operational planning, regulatory or legislative means, such as establishing buffer zones, Wildlife Reserves, Crown Reserves, or creating wildlife protection areas. The interviewee suggested that efforts by the tenure holders to establish "other protected lands" should be recognized.

For the purposes of this thesis, therefore, additional measures beyond that suggested in the *State of the Forest Report* (WNMF 2000) are proposed. Measures are made which are scaled to the study area in question, which reference the variable of forest property rights, and recognize protection of forestlands beyond those defined by WNMF (1999). The following measures are presented:

1. Proportion of each ecoregion / subregion overlapping the study area that has protected status;
2. Area relinquished by tenure holder to create protected areas within the study area;
3. Area of candidate protected area within study area where cutting has been deferred;
4. Area of "other protected lands" within study area.

Reference values:

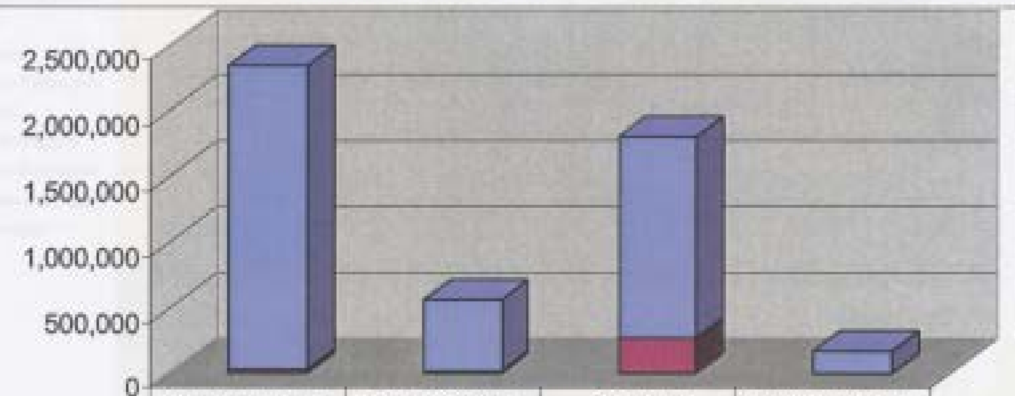
The Department of Environment and Conservation's protected areas strategy (Government of Newfoundland and Labrador 2000c) does not set targets for protected area designation at a forest management district level, nor does it set specific targets for protected area designation for each respective tenure holder. Completion of a representative network of protected areas in the province is the goal of the strategy, and an objective supported by all three tenure holders (ACCC 2001, Government of Newfoundland and Labrador 2003, CBPP 2004). Progress towards final designation of all candidate protected areas within the study area is therefore the suggested reference value for this indicator.

To facilitate comparison of the amount "other protected land" by tenure holder, measures are made which calculate the amount of "other protected lands" in relation to total productive managed forest area of each tenure holder.

Results and Interpretation:

Measure 1: Proportion of each ecoregion / subregion overlapping the study area that has protected status

The area of each ecoregion or subregion overlapping the study area that has protected status is summarized in Figure 19.



	Northcentral subregion	North Shore forest	Central Barrens	Eastern Hyper-Oceanic
Total area (ha)	2,310,742	550,662	1,524,393	160,335
Area protected (ha)	35,315	13,749	270,379	4,401

Figure 19: Area of each ecoregion that falls within the study area having protected status

Translated into percentages, 1.5% of the Northcentral subregion, 2.5% of the Northshore forest ecoregion, 17.4% Central Barrens subregion, and 2.8% of the Eastern Hyper-Oceanic Barrens subregion are protected. A list of protected areas by name, area, and percentage of ecoregion/subregion is provided in Appendix 9.

Measure 2: Area relinquished by tenure holder to create protected areas within the study area

Protected areas within the study area are shown in Figure 20. The area relinquished by tenure holder to create protected areas within the study area is summarized in Table 18. Calculations on changes in tenure were made by referencing Munro's (1978) map of timber allocation on the Island circa 1960 (see Appendix 10).

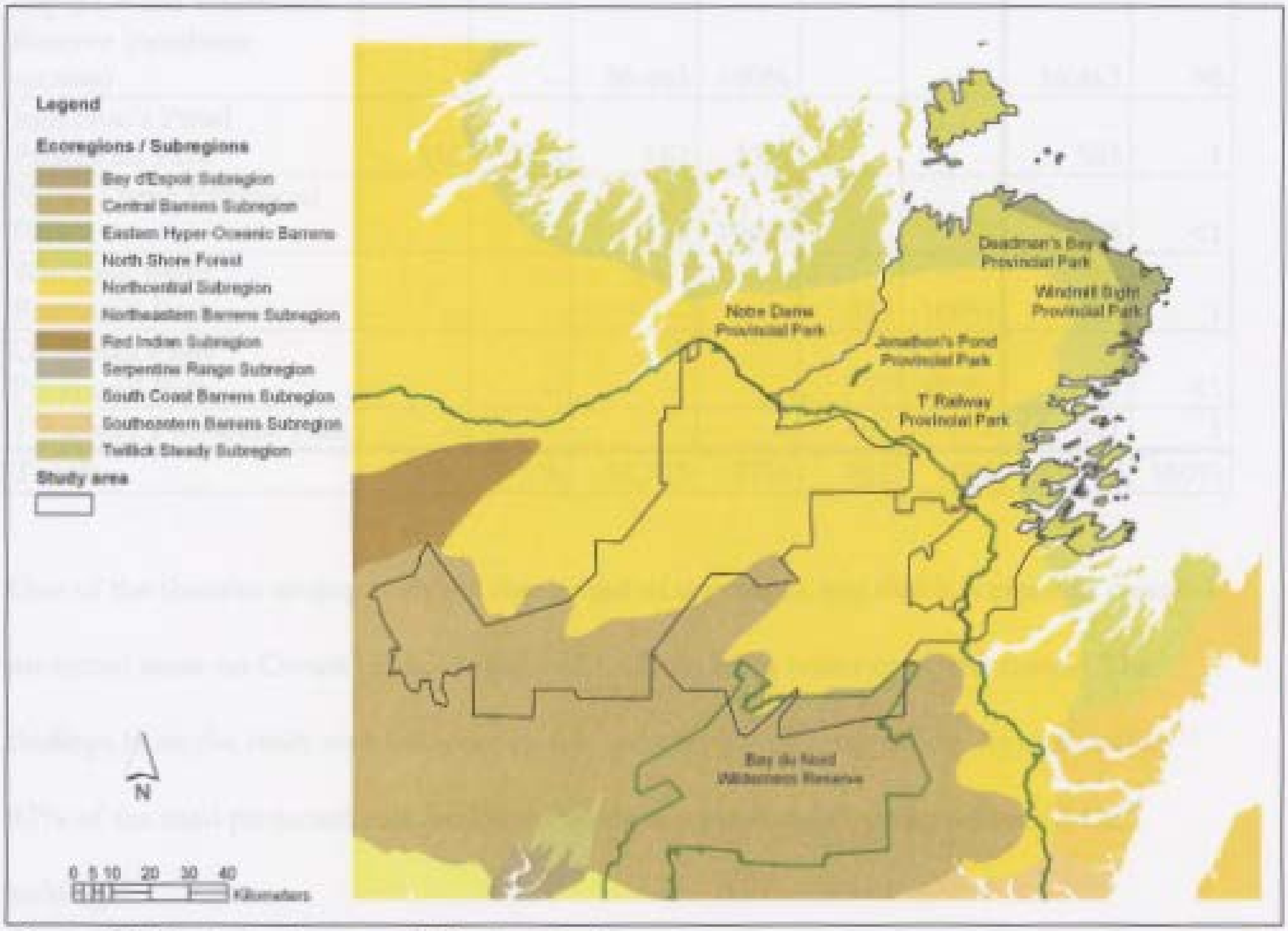


Figure 20: Protected areas within the study area

Table 18: Area relinquished for the creation of protected areas within the study area by tenure holder

	Area relinquished for the creation of protected areas within the study area							
	CBPP		ACCC		Crown		Totals	
Protected Area	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**
Bay du Nord Wilderness Reserve (northern section)	--	--	36,463	100%	--	--	36,463	96
Jonathon's Pond Provincial Park	336	67%	167	33%	--	--	503	1
Notre Dame Provincial Park	--	--	113	100%	--	--	113	<1
Windmill Bight Provincial Park	--	--	--	--	353	100%	353	1
Deadman's Bay Provincial Park	--	--	--	--	77	100%	77	<1
T'Railway Provincial Park	--	--	--	--	401	100%	401	1
Totals	336	1%	36,743	97%	831	2%	37,910	100%

One of the theories arising from the first round of interviews was that it is easier to create protected areas on Crown lands, as opposed to those lands under company tenure. The findings from the study area however do not corroborate this suggestion. Approximately 97% of the total protected area within the study was previously located within ACCC[25] holdings[26].

[25] Protected areas within the study area were established at various times from the 1960s onwards. As noted in Chapter 2, lands currently under the tenure of ACCC were originally held by the AND Company, subsequently Price Pulp and Paper, and then Abitibi-Price.
[26] It should be noted however that the majority of the land relinquished by ACCC for the establishment of the Bay du Nord Wilderness Reserve is classified as barrens or non-productive, scrub forest.

Measure 3: Area of candidate protected area within study area where cutting has been deferred

The area of candidate protected area within the study area where cutting has been deferred by the tenure holder is summarized in Table 19.

Table 19: Candidate protected area within study area where cutting has been deferred by tenure holder

	Area of candidate protected area							
	CBPP		**ACCC**		**Crown**		**Totals**	
Candidate Protected Area	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**
Proposed Rodney Pond Ecological Reserve	9371	91%	956	9%	--	--	10,327	100%

Acknowledging that one of the company tenure holders (ACCC) has made the most significant contribution to protected area establishment within the study area, the academic forest ecologist maintained that it is often more difficult to establish protected areas on lands under company tenure. They stated, "If you know the negotiations around Rodney pond, it's pretty clear that CBPP doesn't want that area protected." One of the pulp and paper sector representatives confirmed that CBPP is against the designation of Rodney Pond as an ecological reserve, but are not against protected areas *per se*. They explained that CBPP supports protected area designation of a site at Gambo Pond.

Measure 4: Area of other protected lands within study

The location and area of other protected lands within the study area by tenure holder is summarized in Figure 21 and Table 20.

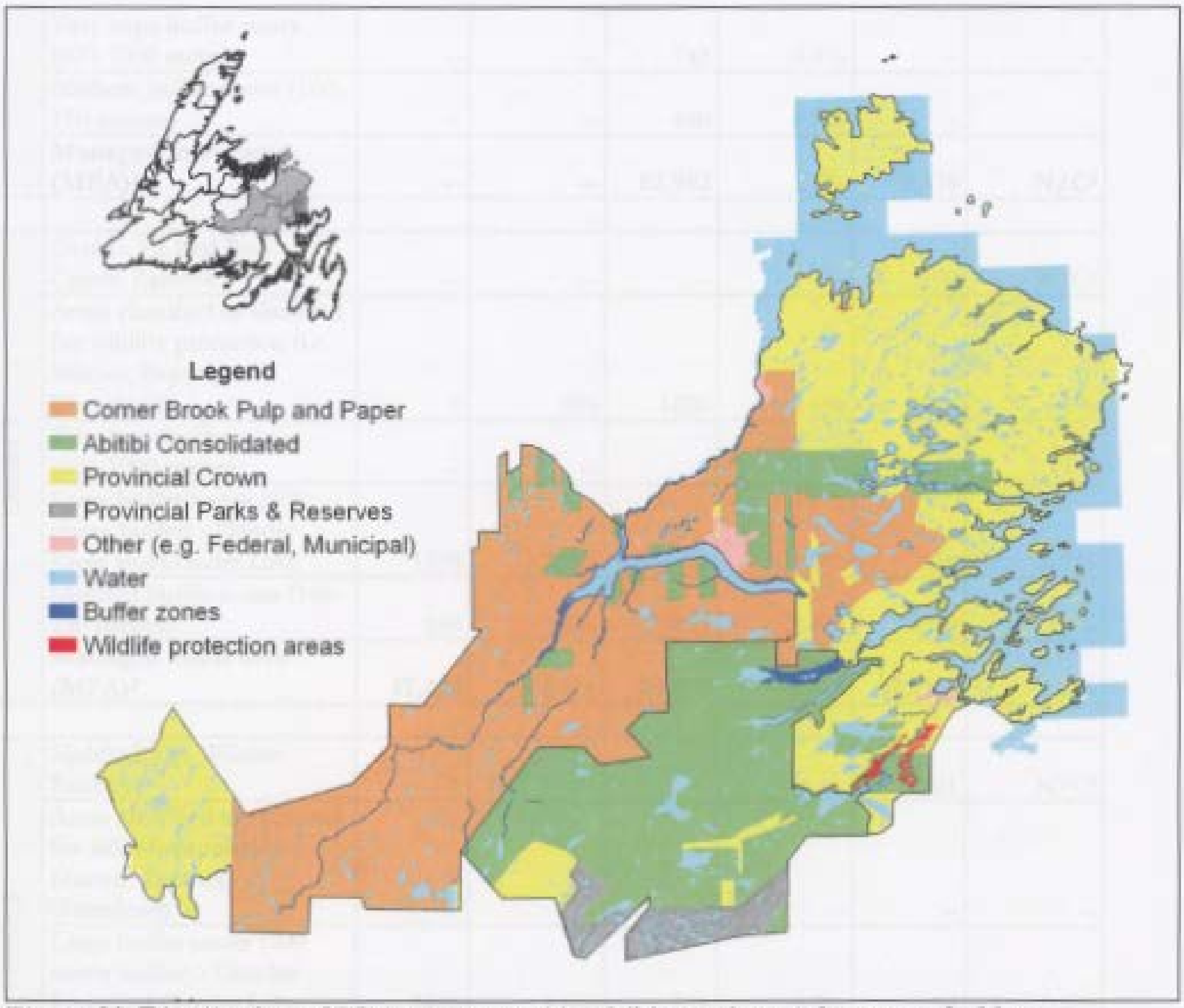


Figure 21: Distribution of "Other protected lands" in study area by tenure holder

Table 20: Area of "other protected lands" in relation to managed forest area by tenure holder.

		Tenure holder					
		CBPP		ACCC		Crown	
Other protected lands[1]		Area (ha)	% in relation to MFA[2]	Area (ha)	% in relation to MFA[2]	Area (ha)	% in relation to MFA[2]
District 4	Middle Ridge Wildlife Reserve	--	--	--	--	14,439	N/C[3]
	Areas classified as alienated for wildlife protection (i.e. Marten, Raptors, Waterfowl)	--	--	156	0.2%	--	--

	Very large buffer zones (600-1000 metres)	--	--	743	0.9%	--	--
	Medium buffer zones (100-150 metres)	--	--	480	0.6%	--	--
	Managed forest area (MFA)[2]	**--**	**--**	**82,982**	**1.7%**	**2,378**	**N/C[3]**
District 5	Grant's Pit Red Pine Crown Reserve	--	--	--	--	100	N/C[3]
District 5	Areas classified as alienated for wildlife protection (i.e. Marten, Raptors, Waterfowl)	8	0%	1620	5.6%	1094	1%
District 5	Very large buffer zones (600-1000 metres)	--	--	--	--	114	0.1%
District 5	Large buffer zones (300 metre buffer) - Gander River and Gander Lake	1338	2.3%	99	0.3%	159	0.1%
District 5	Medium buffer zones (100-150 metres)	689	1.2%	695	2.4%	2239	2.0%
District 5	**Managed forest area (MFA)[2]**	**57,426**	**3.5%**	**28,879**	**8.3%**	**113,164**	**3.2%**
District 6	Middle Ridge Wildlife Reserve	--	--	--	--	551	N/C[3]
District 6	Areas classified as alienated for wildlife protection (i.e. Marten, Raptors, Waterfowl)	--	--	--	--	--	--
District 6	Large buffer zones (300 metre buffer) - Gander River and Gander Lake	2404	1.6%	559	4.6%	36	0.4%
District 6	Medium buffer zones (100-150 metres)	2546	1.7%	197	1.6%	--	--
District 6	**Managed forest area (MFA)[2]**	**148,944**	**3.3%**	**12,074**	**6.2%**	**8757**	**0.4%**

[1] WNMF (1999) defines protected areas as sites having legal protection under the Wilderness and Ecological Reserves Act, Provincial Parks Act, or National Parks Act. "Other protected lands" include areas where logging is prohibited by other regulatory or legislative means. Buffer zone calculations only include forested areas classified as alienated.

[2] Managed forest area (MFA) includes productive, silviculture, cutover, natural disturbance, and alienated land classes.

[3] Wildlife and Crown Reserves fall outside the Managed Forest Area of each tenure holder, and are therefore Not Counted (N/C) in the calculation of "% in relation to MFA".

ACCC leads the other tenure holders in creation of "other protected lands" within the study area. It should be noted that there is a wide variance in the area classified as alienated for the purposes of wildlife protection. One of the pulp and paper sector representatives explained that this variance is simply due to the distribution of wildlife on the landscape. As noted above, the Crown forest manager downplayed the significance of the area alienated by ACCC and the Crown for the purposes of marten habitat protection. They suggested that those lands were alienated "because there was no activity there, so it was an easy thing to do." Furthermore, they explained that this alienation is temporary in nature.

5.2.4 – Indicator: Area and severity of human-caused disturbances (e.g., logging, air pollution, species introduction), and succession pattern afterwards

Measurement methods:

This indicator has two components: human-caused disturbance and subsequent succession patterns. The *State of the Forest Report* (WNMF 2000) reported on human-caused disturbance by charting the area affected by logging within their study area (the Western Newfoundland Model Forest region), over a ten-year period. No measures of subsequent succession patterns were presented in that report.

In addition to logging, forests can be affected by a variety of other human-caused disturbances including air pollution, species introduction, and climate change to name a few. Human-caused disturbances catalogued in the NFSI (2002) include area of recent cutovers[27],

[27] "Cutovers" are areas that have been logged and have not yet been silviculturally treated. The time series for cutover data in the NFSI (2002) can vary by tenure holder and district (e.g. FMD 5 Crown cutover data dates from 1976-2001, while FMD 4 ACCC cutover data dates from 1983-1998). Therefore, the average annual area of cutover has been calculated by tenure holder, and is presented in Tables 21, 22, and 23.

area of cleared lands[28], and length of right-of-ways[29].

Measure 1: Measures for each tenure holder are provided for the average annual area of cutover as a percentage of managed forest area, area of cleared land as a percentage of managed forest area, and length of right-of-ways.

Measure 2: Tracking succession patterns over time following human disturbance would require a historical database. The NFSI (2002) does not include historical data, but provides a snapshot of the current state of the forest. It contains data on areas classed as "not-sufficiently stocked" following disturbance. Not sufficiently stocked areas are sites where no forest succession is occurring. As such, it is one type, arguably the worst type, of succession pattern following a disturbance. Area of not-sufficiently stocked lands by tenure holder is proposed as the second measure for this indicator. It should be noted that this measure is not perfectly suited to report on this indicator as the NFSI (2002) amalgamates all not-sufficiently stocked site data, originating from both human-caused disturbances and natural disturbances. Nevertheless, reporting on area of not-sufficiently stocked land is worthwhile as it will provide information on the reforestation effort and success of each tenure holder.

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[28] "Cleared lands" include residential and agricultural lands, and other changes of the forest landscape.

[29] "Right-of-ways" include all types of roads (paved, unpaved, extraction, trails, abandoned, etc.), abandoned railway lines, and transmission lines.

Reference values:

To facilitate comparison between tenure holders of the amount of human disturbance as well as succession pattern afterwards, measures are made in relation to total productive managed forest area of each tenure holder.

Results and Interpretation:

Measure 1: Human-caused disturbance

Selected human-caused disturbances by tenure holder are illustrated in Figure 22 and summarized in Tables 21, 22, and 23.

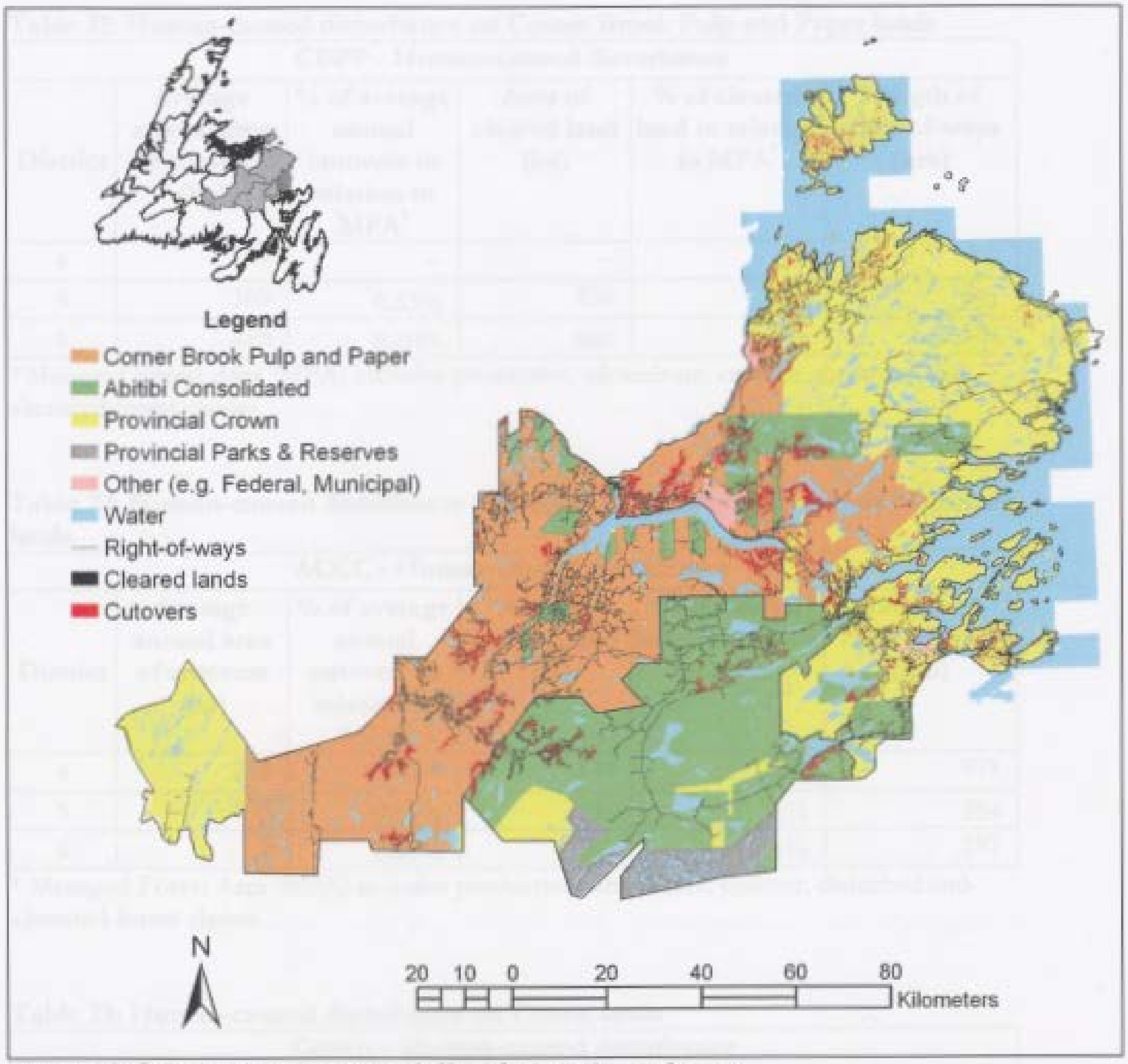

Figure 22: Selected human-caused disturbances in study area

Table 21: Human-caused disturbance on Corner Brook Pulp and Paper lands

CBPP - Human-caused disturbance					
District	Average annual area of cutovers (ha)	% of average annual cutovers in relation to MFA*	Area of cleared land (ha)	% of cleared land in relation to MFA*	Length of right-of-ways (km)
4	--	--	--	--	--
5	303	0.53%	356	1%	951
6	296	0.20%	960	1%	2,584

*Managed Forest Area (MFA) includes productive, silviculture, cutover, disturbed and alienated forest classes.

Table 22: Human-caused disturbance on Abitibi Consolidated Company of Canada lands

ACCC - Human-caused disturbance					
District	Average annual area of cutovers (ha)	% of average annual cutovers in relation to MFA*	Area of cleared land (ha)	% of cleared land in relation to MFA*	Length of right-of-ways (km)
4	277	0.33%	144	<1%	871
5	189	0.65%	176	1%	354
6	6	0.05%	101	1%	287

* Managed Forest Area (MFA) includes productive, silviculture, cutover, disturbed and alienated forest classes.

Table 23: Human-caused disturbance on Crown lands

Crown – Human-caused disturbance					
District	Average annual area of cutovers (ha)	% of average annual cutovers in relation to MFA*	Area of cleared land (ha)	% of cleared land in relation to MFA*	Length of right-of-ways (km)
4	0	0%	0	0%	7
5	410	0.36%	4,077	4%	2,055
6	0	0%	11	<1%	24

* Managed Forest Area (MFA) includes productive, silviculture, cutover, disturbed and alienated forest classes.

Tables 21, 22, and 23 indicate that the percentages of cutovers in relation to managed forest area on company lands are higher in FMD 5 compared to their respective lands on FMD 4 and FMD 6. No interviewees could provide an explanation for this higher rate of cutting.

Commenting on the measurement methods for this indicator, one of the pulp and paper sector representatives noted that they do not consider logging (as represented by the area of cutovers) as a negative human disturbance. While cutovers are reforested with time, they explained, forest is permanently destroyed on lands cleared for purposes other than forestry. Their point was that logging forestland and clearing forestland are two very different types of human-caused disturbance.

One of the suggestions from the scoping interviews is that conversions of forestland to non-forest uses occur more easily on Crown land than company land. The data from the study area appear to support this theory as 4,077 hectares or 4% of Crown land in relation to managed forest area has been cleared in FMD 5, while the companies average approximately 1% per management district. The academic forest ecologist suggested that agriculture development areas account for the higher percentage of cleared Crown land in FMD 5. It should also be noted that the location of communities, primarily in coastal areas of Crown land in FMD 5, also contributes to higher percentages of cleared lands.

Measure 2:

The percentage of Not-stocked forest sites in relation to the managed forest area of each tenure holder is summarized in Table 24.

Table 24: Percentage of Not-stocked forest sites in relation to managed forest area of each tenure holder

District	CBPP		ACCC		Crown	
	Area not stocked (ha)	% of MFA	Area not stocked (ha)	% of MFA	Area not stocked (ha)	% of MFA
4	--	--	3,857	5%	37	2%
5	4,861	8%	2,779	10%	2,683	2%
6	4,601	3%	361	3%	25	0%
Total	9,462	5%	6,997	6%	2,745	2%

* Managed Forest Area (MFA) includes productive, silviculture, cutover, disturbed and alienated forest classes.

Table 24 indicates that the areas of Not-stocked sites are in highest proportion on company lands in FMD 5. The academic forest ecologist commented that, "My impression [is that] the companies like to talk about the silviculture that they're doing, but it's much, much less than that on Crown. I think the Crown was always easier faced with the cost of silviculture, especially site preparation." They were unsure as to why FMD 5 has higher percentages of Not-stocked sites in comparison to the other two districts, but speculated that it might be related to the 1961 fire. The Crown forest manager echoed the view that the Crown tends to be more aggressive than the companies in carrying out silviculture activity such as replanting.

One of the pulp and paper sector representatives commented that the "backlog" of Not-stocked sites in FMD 5 and 6 on CBPP lands has been recognized as a problem. Historically, they explained, $2.5 million has been spent on silviculture annually, but that has recently been increased to $3 million, with the goal of reaching $4 million. When asked why the backlog has occurred in FMDs 5 and 6, they explained that the priority for planting has been on districts closer to the Corner Brook mill.

The second pulp and paper sector representative commented that the Not-stocked data drawn from the NFSI (2002), specifically for ACCC's FMD 5 lands, is likely out-of-date. In the past year they explained that ACCC had planted 3 million trees across the Island, and FMD 5 was targeted for replanting.

5.2.5 – Indicator: Change in population level or ranges of Woodland Caribou

Interview subjects who selected the indicator "Change in population level or ranges of selected species" were asked to select a species that would be appropriate for study. Several interview subjects suggested Woodland Caribou. Woodland Caribou was also the species used in the *State of the Forest Report* (WNMF 2000) for reporting upon this indicator. The WNMF (2000) report for this indicator documents population level changes for two herds whose ranges fall within or overlap with their study area (the Western Newfoundland Model Forest region), over a three year time period.

The northern range of the Middle Ridge and Mount Peyton caribou herds overlaps with southern portion of the study area (primarily FMDs 4 and 6). Wildlife Division provided data on the range of the Middle Ridge / Mount Peyton[30] caribou herd for the years 1984 and 2000. Reliable population level data for these herds were not available.

[30] The data provided by Wildlife Division consolidates information on the Middle Ridge and Mount Peyton herds. For the purposes of this thesis, therefore, these caribou are referred to as the Middle Ridge / Mountain Peyton caribou herd.

Measurement methods:

The indicator, as designed, provides no information on the interaction of forest property rights and the changes in caribou population levels or range. For the purposes of this thesis, therefore, measures are proposed that reference the variable of forest property rights.

Two different measures of this indicator have been carried out:

1. A comparative review of management actions of each tenure holder in relation to Woodland Caribou has been made.
2. GIS analysis was undertaken to determine the change in the range of the Middle Ridge / Mount Peyton caribou herd in relation to the total area of each tenure holder.

Reference value:

Caribou biologists have not identified a "healthy" or "normal" range or population level for the Middle Ridge / Mount Peyton caribou herd. The reference value for this indicator is therefore the 1984 range data.

Results and Interpretation:

Measure 1: Comparative review of management actions of each tenure holder in relation to Woodland Caribou

The *Environmental Protection Guidelines for Ecologically Based Forest Resource Management* (Government of Newfoundland and Labrador, n.d.) outline the management guidelines stipulated by the Crown in relation to Woodland Caribou. These guidelines prohibit logging activity in areas of calving and post-calving, where identified by Wildlife Division. Additionally, the guidelines stipulate that forest access roads, borrow pits and quarries should avoid sensitive areas such as calving grounds, post-calving areas, caribou migration routes, caribou rutting areas, and winter areas. All three tenure holders are required to consult with the Department of Environment and Conservation's Wildlife Division on the preparation and design of their harvesting plans. The *Environmental Protection Guidelines for Ecologically Based Forest Resource Management* are intended to be applied universally to all three tenure holders. The sustainable forest management plans of CBPP (2004) and ACCC (2001) do not include additional management actions in relation to Woodland Caribou. ACCC's *Sustainable Forest Management Plan 2001-2021* (2001) does however make general provisions for wildlife, such as maintaining wildlife corridors on large cutover areas.

The Crown forest ecologist indicated that Wildlife Division has recently drafted new forest management guidelines affecting Woodland Caribou, and is negotiating their final approval with each of the three tenure holders. In describing the ongoing negotiations towards adoption of the guidelines, they commented that the three tenure holders tend to "stand together." If one of the tenure holders is in agreement with a proposed protection measure, the other two tend to be in agreement as well. Conversely, they tend be unified in opposition as well.

Measure 2: Change in caribou range in relation to the managed forest area of each tenure holder

Figures 23 and 24 show the year-round range of the Middle Ridge herd for the years 1984 and 2000 in relation to the study area. It should be noted that caribou are never evenly distributed across their range, as the year-round range maps might suggest, but vary in the density of animals in any one location. Additionally, caribou are located in different areas within the total range during different seasons (e.g. primarily on the south coast during winter).

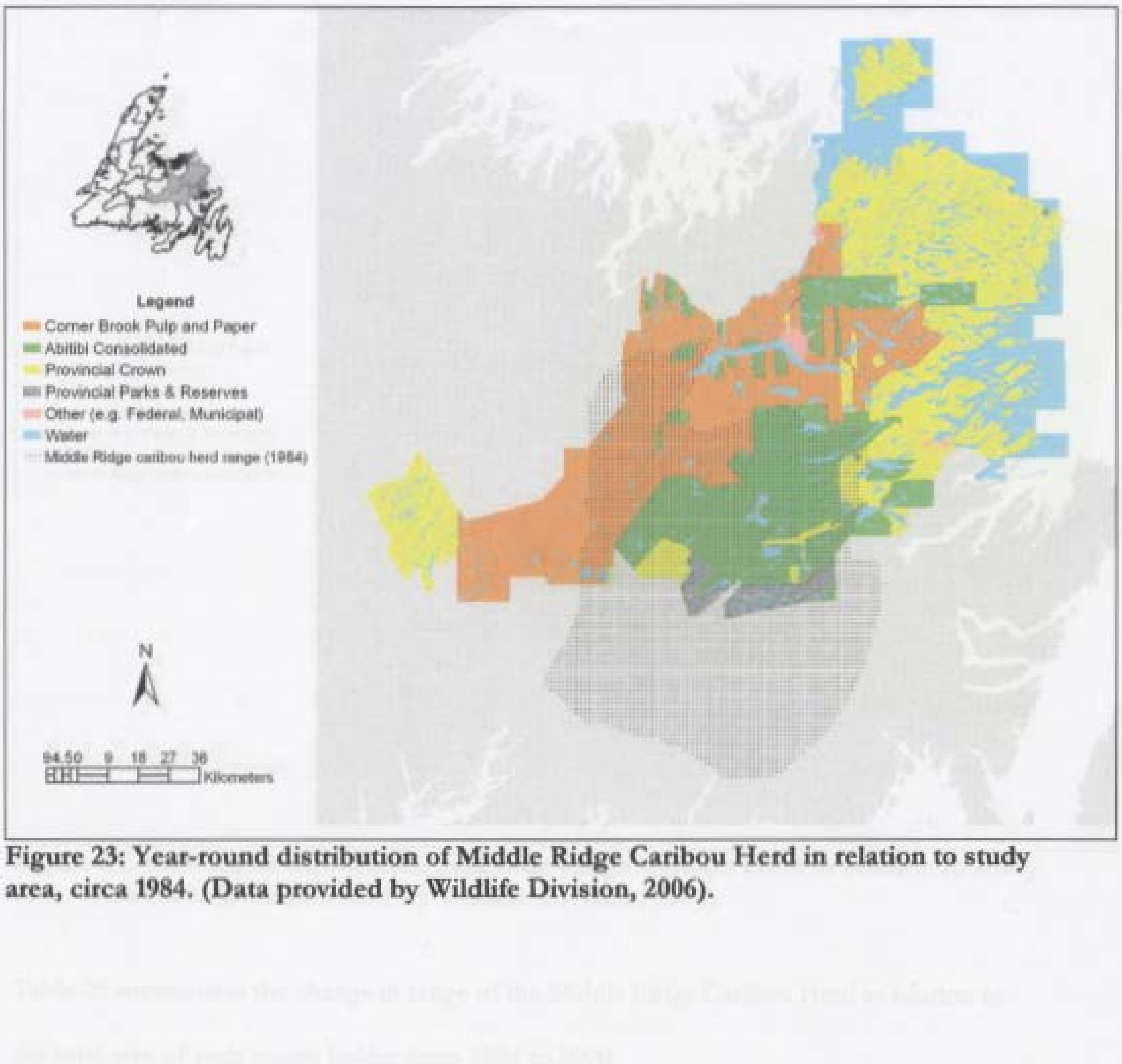

Figure 23: Year-round distribution of Middle Ridge Caribou Herd in relation to study area, circa 1984. (Data provided by Wildlife Division, 2006).

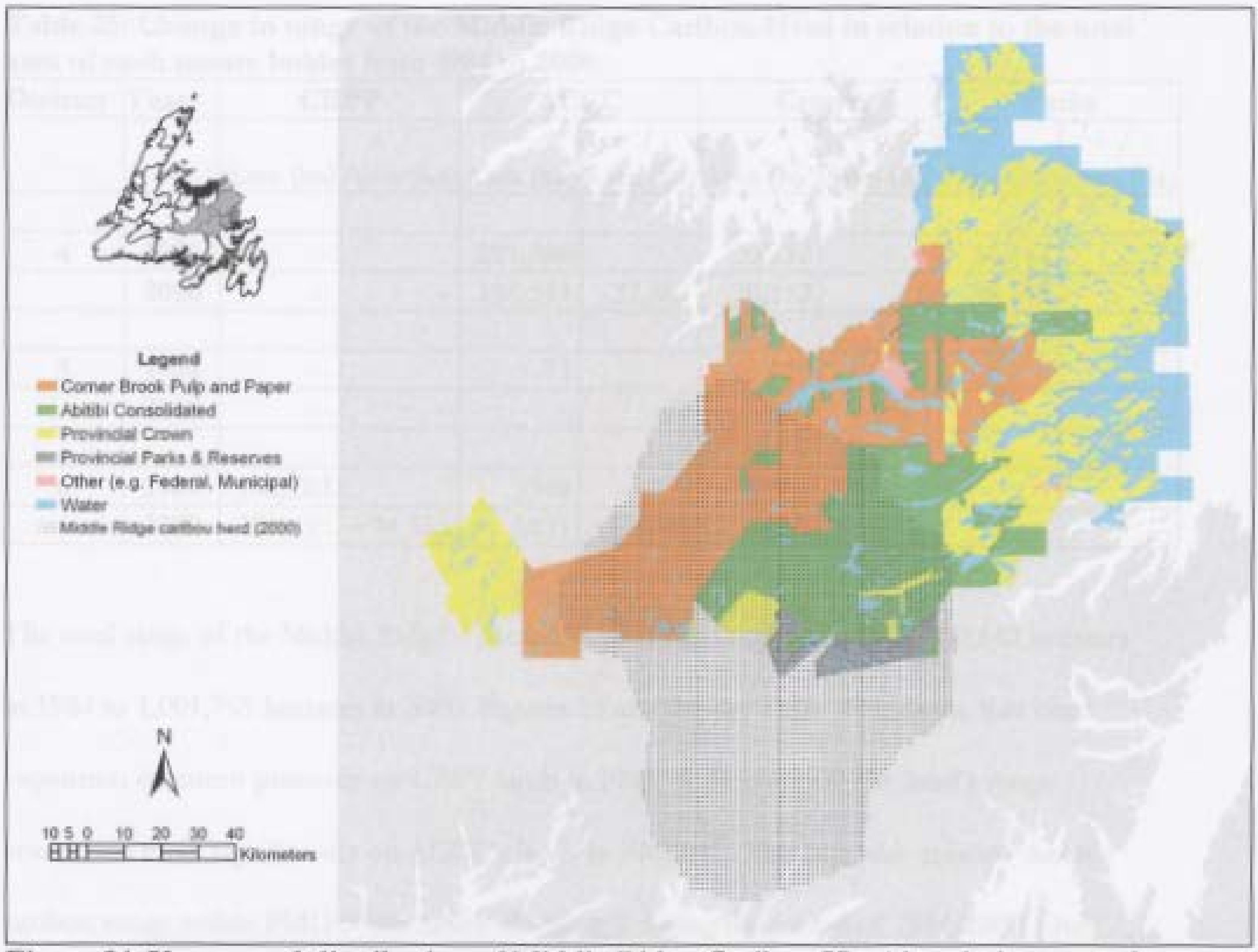

Figure 24: Year-round distribution of Middle Ridge Caribou Herd in relation to study area, circa 2000. (Data provided by Wildlife Division, 2006).

Table 25 summarizes the change in range of the Middle Ridge Caribou Herd in relation to the total area of each tenure holder from 1984 to 2000.

Table 25: Change in range of the Middle Ridge Caribou Herd in relation to the total area of each tenure holder from 1984 to 2000.

District	Year	CBPP		ACCC		Crown		Parks	
		Area (ha)	+ / - Area (ha)	Area (ha)	+ / - Area (ha)	Area (ha)	+ / - Area (ha)	Area (ha)	+ / - Area (ha)
4	1984	--		221,080		20,212		36,462	
	2000	--	--	193,693	-27,387	20,212	0	36,462	0
5	1984	--		77		10,029		--	
	2000	--	--	--	-77	366	-9663	--	--
6	1984	156,282		5369		551		--	
	2000	250,835	+94,553	3621	-1748	551	--	--	--

The total range of the Middle Ridge / Mount Peyton herd expanded from 880,642 hectares in 1984 to 1,001,765 hectares in 2000. Figures 23 and 24 and Table 25 indicate that herd expansion occurred primarily on CBPP lands in FMD 6. In contrast, the herd's range contracted most significantly on ACCC's lands in FMD 4[31]. The data also indicate that the caribou range within FMD 5 was nearly eliminated during the period of 1984-2000. Only 366 hectares on Crown land remain as of 2000 in FMD 5.

The academic forest ecologist concluded that it is difficult to link any change in caribou range that this data might show, with the forest management actions of any one tenure holder. They stated, "I'd say there's no indication of change in range use. There may be a change in range use, but you don't have the data to show it." They recommended that analysis of range changes on a seasonal basis between 1984 and 2000, as opposed to year-round range data, would be more meaningful, but likely reveal little change.

[31] Though the caribou range has shifted from ACCC land in the north-eastern portion of FMD 4, the animals have increased occupancy of ACCC lands in FMD 11, west of FMD 6.

Both pulp and paper sector representatives expressed reservations about the data. One explained, "I have great difficulty in trying to relate the impact of forest harvesting on caribou. Caribou are constantly moving to get food. The area is so big it's hard to say why they moved." They pointed out that from a low point in the early 1950s, the total caribou population on the Island grew to a peak in 1995. During that same period, the rate of logging on CBPP lands has reduced from 2.5 million cubic metres of wood in the early 1950s (which includes wood exports) to the current amount of approximately 800,000 cubic metres.

The second pulp and paper sector representative commented, "There's too many other factors affecting caribou – hunting, predation, over-browsing, coyotes, etc.. The goal for caribou set by Wildlife Division was to maximize habitat. The population would have to come down eventually. They've now eaten themselves out of house and home."

The Crown forest manager noted that over the past five years, populations of all caribou herds on the Island, whether located in areas where there is little forestry activity such as the south coast, or in areas of high forestry activity like in central Newfoundland, have been declining. They cited a variety of potential causes for the decline including habitat impacts, hunting pressure, and climate change. They also questioned the response of caribou herds to stress, querying whether "they expand their range because they have to go further to find food, or do they shrink their range because there's fewer of them using it?". Given these uncertainties, they were reluctant to attempt to draw any conclusions from the data.

5.3 – Summary of indicator measure results

Table 26 provides a summary of all indicator measure results by tenure holder. Results having a positive effect on forest health and biodiversity are indicated by the symbol [+], while negative measures are indicated by [–]. Measures that were ambiguous are indicated by the symbol [A].

Table 26: Summary of all indicator measure results by tenure holder.

Indicator	Tenure holder		
	CBPP	**ACCC**	**Crown**
5.2.1 *Measure 1(4): Area classified as "alienated" for purposes of marten habitat protection*	[–] CBPP has not alienated any land from cutting for purposes of marten habitat protection.	[+] ACCC has alienated the most land from cutting for purposes of marten habitat protection.	[+] The Crown has alienated some land from cutting for purposes of marten habitat protection.
Measure 2: Percentage of suitable marten habitat in relation to managed forest area	[A] CBPP has largest area of suitable marten habitat in relation to managed forest area. This may be due to differences in site condition, natural disturbance history, logging history, and / or distance to processing facilities.	[A] ACCC has less suitable marten habitat in relation to managed forest area than CBPP. This may be due to differences in site condition, natural disturbance history, or logging history.	[A] The Crown has less suitable marten habitat in relation to managed forest area than CBPP. This may be due to differences in site condition, natural disturbance history, or logging history.
5.2.2 *Measure 2: Distribution of forest working groups*	[–] Low proportion of Black Spruce in FMD 5 when using TNNP as a reference value. This may be due to historic domestic logging activity and/or the natural disturbance history.	[+] The proportion of Black Spruce in FMD 4 corresponds to that found in TNNP. [-] There is a low percentage of Black Spruce in FMD 5 and 6 when compared to TNNP.	[+] The percentage of Black Spruce in FMD 4 and 6 is high. [–] FMD 5 has the highest discrepancies in distribution of forest working groups when compared to TNNP.

Measure 3: Age class structure	[+] If using Van Wagner's theoretical age class distribution as a reference value, CBPP has maintained the highest percentage of old forest. This may be a function of the size of their tenure area, and /or distance from their mill.	[+] If using balanced age-class as a reference value, ACCC's holdings most closely approximate such a target.	[–] If using Van Wagner's theoretical age class distribution as a reference value, the Crown has the lowest proportion of old forests. This may be due to the natural disturbance history in this region.
5.2.3 *Measure 2: Area relinquished by tenure holder to create protected area* *Measure 3: Area of candidate protected area where logging activity has been deferred* *Measure 4: Area of "other" protected lands.*	[A] A small amount of land has been relinquished. [A] Area has been deferred, but CBPP is opposed establishment of a protected area at that site. [–] Relatively little land has been set aside as "other" protected land. This may be a function of site condition, specifically the distribution of wildlife on the landscape).	[+] ACCC has relinquished the largest amount of land for the creation of protected areas. [A] Little candidate protected area falls on ACCC lands. [+] Have the highest percentage of "other" protected lands.	[A] A small amount of land has been relinquished. [A] No candidate protected area falls on Crown lands. [A] Have set aside some "other" protected lands.
5.2.4 *Measure 1: Average annual area of cutover as a percentage of managed forest area*	[A] The rate of cutting on company land is higher than that of Crown land in FMD 5. No explanation was provided as to why.	[A] The rate of cutting on company land is higher than that of Crown land in FMD 5. No explanation was provided as to why.	[+] Rate of cutting is relatively lower on Crown land. No explanation was provided as to why.

Measure 2: Area of cleared land as a percentage of managed forest area *Measure 3: Percentage of not-stocked sites in relation to managed forest area*	[+] Percentage of cleared company land is lower than the percentage of cleared Crown land. [–] There is a relatively high percentage of not-stocked sites in FMD 5.	[+] Percentage of cleared company land is lower than the percentage of cleared Crown land. [–] There is a relatively high percentage of not-stocked sites in FMD 5.	[–] Approximately four times the amount of Crown land has been cleared compared to company land. [+] Crown lands have the lowest percentage of not-stocked sites.
5.2.5 *Measure 2: Change in Middle Ridge/ Mount Peyton Caribou Herd range in relation to managed forest area of each tenure holder.*	[A] Difficult to link any change in caribou range with management actions of tenure holder.	[A] Difficult to link any change in caribou range with management actions of tenure holder.	[A] Difficult to link any change in caribou range with management actions of tenure holder.

[+] = Positive or beneficial measure in reference to forest health and biodiversity
[–] = Negative or detrimental measure in reference to forest health and biodiversity
[A] = Ambiguous indicator measure in reference to forest health and biodiversity

6 – Conclusions:

This chapter presents conclusions on the research hypotheses proposed in Chapter 2, the research methodology, and the contribution this research can make to future decisions on the reallocation of forest property rights in Newfoundland.

Management of all forestlands in Newfoundland, irrespective of tenure type or tenure holder, is constrained by several pieces of legislation (e.g. *Forestry Act* 1990, *Fisheries Act* 2004, *Environmental Protection Act* 2002, *etc.*), is guided by common, over-arching policies (e.g. *Provincial Sustainable Forest Management Strategy* 2003, Government of Newfoundland and Labrador), and controlled by a variety of guidelines such as those governing specific logging practices (e.g. *Environmental Protection Guidelines for Ecologically Based Forest Resource Management (Stand Level Operations)* n.d., Government of Newfoundland and Labrador). Forest tenure statutes and grants in combination with the above-mentioned suite of legislation, policy and guidelines, compose a regulatory regime which both facilitates and constrains the exercise of forest property rights. The regulatory regime serves to standardize or equalize how each of the three main tenure holders in Newfoundland (Corner Brook Pulp and Paper Ltd. (CBPP), Abitibi Consolidated Company of Canada Inc. (ACCC), and the Crown), exercise their respective property rights. This thesis has attempted to measure the actual, relative impact of forest management activities of each property holder on forest health and biodiversity in Forest Management Districts (FMD) 4, 5 and 6, (North-eastern Newfoundland) in an effort to understand the influence of the tenure system on forest health and biodiversity in Newfoundland.

An evaluation framework for the research was developed through scoping interviews with nine forest management experts. The forest management experts selected five indicators for forest health and biodiversity, drawn from the Western Newfoundland Model Forest's *Criteria and Indicators of Sustainable Forest Management: A practical guide to using local level indicators in Newfoundland and Labrador* (1999), which were measured using Geographic Information Systems analysis. The indicators selected to form the evaluation framework include: area of suitable habitat for Newfoundland Marten; area of each forest type by age class; proportion of each ecoregion that is in protected status; area and severity of human-caused disturbance and succession pattern afterwards; and change in population range of the Middle Ridge / Mount Peyton caribou herd. Interpretation of the indicator measures was guided by a second round of interviews with five forest management experts, representing different perspectives of the forestry community.

Assessing the influence of forest property rights on forest health and biodiversity in North-eastern Newfoundland has proven to be a challenging task. The interactions between natural disturbance events, anthropogenic disturbances, forest management activities, and both native and non-native species have collectively influenced current forest conditions in the study area. This poses a very tangled web for a forest researcher attempting to understand the relative influence of forest tenure on forest condition. The interpretation results of indicator measures in Chapter 5 suggests that a tenure holder's "performance" on an indicator is often, if not always, influenced by a mix of factors related to property rights (e.g. cutting practices, land use changes, pressure on the landbase, etc.) and factors not related to property rights (e.g. natural disturbance history, local forest site conditions, etc.).

6.1 – The influence of property rights on forest health and biodiversity

The scoping interviews, as summarized in detail in Chapter 5, pointed to a variety of ways in which property rights might influence forest health and biodiversity, including cutting practices, the size of tenure blocks, issues of compensation, enforcement capacity, pressures on the land base, and land use changes. Some of these factors do appear to affect indicator measure results, while others showed no affect on indicator measure results.

Cutting practices

One of the most obvious influences related to differences in cutting practices on Crown versus company lands is the presence of mixed-age stands on Crown land in FMD 5. These mixed-age stands are a result of selective cutting practices carried out by domestic loggers, usually in areas of close proximity to communities. Communities in the study area tend to be located in coastal areas, which are generally under Crown land tenure. The uneven distribution of communities in relation to forest property rights boundaries (i.e. most Newfoundland communities are located in coastal areas on Crown land) is a characteristic of the tenure system on the Island. This in turn affects forest conditions as the selective cutting by domestic loggers is only carried out on Crown lands, and tends to produce mixed-age forest stands.

Land use changes

Property rights also appear to influence the types of land use changes affecting forested areas. Crown land in FMD 5 has approximately four times as much cleared land, relative to managed forest area, as company lands. This measure corroborates the suggestion, proposed in the scoping interviews, that land use changes occur more frequently on Crown land than company lands. It was also suggested that protected areas are more easily and frequently established on Crown land, as opposed to company lands. Measurement results related to the influence of tenure on protected area establishment are mixed. ACCC leads all tenure holders in the amount of land relinquished for the establishment of protected areas within the study area, as well as in the amount the amount of land set aside under other protective measures (e.g. buffer zones, wildlife protection areas, and other reserves). Yet, CBPP is opposed to the designation of the proposed Rodney Pond Ecological Reserve due to timber interests. It would appear difficult to make a generalized conclusion regarding the influence of tenure on protected area establishment. Tenure holders appear to assess their interests in a proposed protected area on a case-by-case basis.

Pressures on the land base

The results of the indicator measures are inconclusive as to whether pressures on the land base of one tenure holder are higher than another. The percentage of average annual cutovers in relation to managed forest area is nearly two times as high on company lands in FMD 5 as compared to Crown lands. As well, the amount of Not-stocked forest on company lands is four to five times higher than that of Crown land in FMD 5. These figures suggest that a higher rate of cutting and less replanting occur on company lands. Yet the areas of cutover and Not-stocked forest on company lands in FMDs 4 and 6 are "average". It is therefore difficult to draw definitive conclusions as to which tenure holder's land base might be under the most severe pressure.

One of the interview subjects suggested two alternative methods to measure the relative amount of human-caused disturbance (and pressure on the land base). Firstly, one could measure the annual allowable cut in relation to the amount of managed forest area of each tenure holder. Secondly, one could measure the amount of land in "natural condition" by calculating road and infrastructure density in each tenure block.

Size of tenure blocks

One of the interviewees participating in the scoping interviews suggested that tenure blocks of small size can limit the manoeuvrability and flexibility of the tenure holder when attempting to design cutting plans which meet the needs of sensitive wildlife species. The data do not indicate, however, a negative relationship between small size of tenure blocks and the amount of suitable Newfoundland Marten habitat in the study area. On the contrary, in the case of each of the tenure holders, the percentage of suitable marten habitat in relation to total managed forest area increases with decreasing size of the total managed forest area. The exception is Crown land in FMD 4.

Proximity to processing facilities

The proximity of processing facilities to the tenure area was not identified in the scoping interviews as a possible way in which property rights might influence forest health and biodiversity, but it did emerge in the interpretation of indicator results. CBPP land in FMD 5 was measured to have the highest percentage of suitable marten habitat in relation to managed forest area amongst all tenure holders and districts. A possible explanation for this, as suggested by two interviewees, is the relatively high transportation costs of shipping timber from this eastern district to the CBPP mill in Western Newfoundland. Indicator measure results also revealed that the highest proportion of Not-stocked CBPP forest land occurs in FMD 5. One of the interview subjects suggested that FMD 5 has lagged behind in reforestation efforts, as it has been a lower priority area for CBPP, given its distance from the mill.

Indicator measure results therefore suggest that the location of a tenure holder's timber in relation to their processing facilities influences decisions on where cutting occurs, and this in turn affects forest health and biodiversity (in particular the forest age-class structure, amount of suitable habitat for sensitive wildlife species such as Newfoundland Marten, and reforestation efforts). This finding corroborates Pollard's (2003) research which concludes that historically, logging effort has expanded outward from mill sites such as ACCC's Grand-Falls mill, first targeting timber in densely forested river valleys, and gradually, over time moving to more distant forested areas.

6.2 –The influence of natural disturbances and site condition factors on forest health and biodiversity

The research attempted to control for differences in ecological conditions across tenure boundaries by selecting an area of relatively uniform ecoregion composition. Nevertheless, all interview participants who interpreted indicator measures pointed to differing affects of natural disturbance events (e.g. the 1961 fire primarily affected Crown land in FMD 5) and differences in local forest site conditions as the reason behind differences in some indicator measure results.

Though differences in cutting intensity may account for why CBPP land in FMD 5 contains the highest proportion of suitable Newfoundland Marten habitat, interviewees also pointed to the influence of forest site condition. CBPP forest in FMD 5 is fairly contiguous, a feature the habitat suitability model selects for, while in comparison, ACCC lands in FMD 4 tend to be more naturally fragmented. Similarly, interview subjects argued that any differences in the amount of land alienated for wildlife protection is not a function of the management preferences of tenure holders, but rather, differences in site condition, and in turn, distribution of wildlife species on the landscape.

Similarly, the uneven impacts of natural disturbance events influence some indicator measures. Crown forest in FMD 5, for example, has what appears to be an unnatural abundance of stands in the 20-40 year age class. These stands, however, were established following the 1961 fire that severely affected the Crown forest area of FMD 5. There is therefore a lower percentage of older forests in this region, and in turn, a relatively low percentage of suitable Newfoundland Marten habitat.

6.3 – Challenges in interpreting indicator measures

In examining the relationship between property rights and forest health and biodiversity, it is a significant challenge to understand the relative effect of factors related to property rights, and factors not related to property rights. Indicator measures proposed in Chapter 5 were designed to focus on the relative influence of property rights on forest conditions. Nevertheless, the interpretation of indicator measures presented in Chapter 5 is often contradictory, unclear, or "noisy". This stems, in part, from weaknesses in the research methods, problems of spatial and temporal scale for some indicators, and problems related to data quality, and in part, from the nature of the research itself.

6.3.1 – Research methods

The research methods employed in this thesis draw on work of Wright (2002). Wright's (2002) research on forest sustainability monitoring using a criteria and indicator approach incorporates the multiple, and often conflicting perspectives of scientists, loggers, forest managers, and others who are concerned with sustainable forest management. The research challenge, in such an environment, is that indicator results can be interpreted differently, depending on who is carrying out the interpretation. Wright (2002) resolves the challenge of data interpretation in an environment of conflicting values by incorporating group discussion of interview subjects throughout the research, from initial selection of indicators, to determination of measurement methods and reference values, and final interpretation of results. The benefit of a collaborative process is that research participants can in theory, collectively resolve conflict which surfaces in the selection of reference values or interpretation of results.

The method employed in this thesis did draw on the divergent perspectives of scientists, Crown and company forest managers, academics, and a non-governmental environmental organisation. Through individual interviews, indicators were selected, feedback was provided on reference values and measurement methods, and interpretation of indicator measures was carried out. A "narrative" style interpretation was provided for each indicator measure, reflecting the various perspectives of interview participants. The weakness of individualized interviews, however, is that they did not allow for resolution of conflicts surrounding selection of reference values or interpretation of indicator results. As such, two different baseline reference values for age-class structure are presented for the indicator "Area of each forest type by age class". A group discussion of interview participants may have served to select a single, acceptable reference value, as well as assisted in sharpening the interpretation results of all indicator measures. Unfortunately, a group discussion of interview participants was simply not possible due to the logistical constraints – the nine interview subjects were located in six different towns in three different provinces.

It is also possible that a group discussion approach would *not* serve to resolve conflicts concerning reference values and interpretation of indicator measures. As noted in Chapter 2, though there is general agreement with the broadly defined Criteria and Indicators for Sustainable Forest Management (CCFM 1995, 1997, 2000, 2003a), competing actors have challenged attempts to set provincial- and management district-scale targets and thresholds for the Criteria and Indicators. As Ross (1995) explains, "even though all concur that minimum standards must be established, disagreements arise about the required level of specificity and constraint, the level of ecosystem "health" to be maintained, and the way in which this "health" may be best achieved" (318).

6.3.2 – Problems of spatial and temporal scale

The five indicators that form the evaluation framework for this thesis (listed above) are a mix of landscape, habitat, and species-level indicators. As such, they present a broad measure of forest health and biodiversity in the study area, at different spatial scales. Indicators scaled to the study area in question, which directly measured forest conditions and human disturbance (i.e. area of each forest type by age-class and area and severity of human-caused disturbance and succession pattern afterwards) seemed to provide the best quality data, and most informative data for this research question. The indicator measuring the amount of suitable habitat for Newfoundland Marten also proved informative, though some interviewees questioned the parameters used in the habitat suitability model.

Indicators for the range of the Middle Ridge / Mount Peyton caribou herd, and amount of each ecoregion with protected area status posed a challenge in that the spatial scale of these indicators does not match the spatial scale of the study area. Only the northern portion of the Middle Ridge / Mount Peyton herd's range overlapped with the study area. None of the interviewees were willing to make any judgement regarding the link between forest management activities and changes in herd range. Most stated that this indicator measure is simply too "noisy", indicating that there are a variety of factors which could account for a shift in herd range. One interviewee pointed out that year-round range data was too coarse, and seasonal data on range changes would be more informative. As such, this indicator proved to be the least informative in helping to describe the relationship between forest property rights and forest health and biodiversity.

Similarly, the measure for the amount of each ecoregion in protected status posed problems of spatial scale for this research. Given that some of the ecoregions overlapping with the study area were much larger in size than the study area, while other overlapping ecoregions were fragmented with portions at great distance from the study area, this measure reported on protected areas occurring both inside and outside the study area boundary. As only the study area was of interest to this research, this measure produced data at an undesired scale. In proposing additional measures for this indicator, scaled to the study area, this indicator was modified to provide information relevant to the research question.

Ideally, this thesis would report on all indicators for a specified time period. However, the temporal scale of data tended to vary with each indicator. Some indicator results simply provide a "snapshot" in time, gained from a single temporal reference point (e.g. the area of suitable Newfoundland Marten habitat, area of forest type by age class, and amount of protected area). The measure for range of the Middle Ridge / Mount Peyton caribou herd reported results based on two points in time, 1984 and 2000. Indicator results for the area of cutovers (one of the measures for the indicator on area of human-caused disturbance), presented averaged yearly figures as the Newfoundland Forest Stand Inventory (NFSI) (2002) included a range of time series, which varied by district and tenure holder (e.g. FMD 5 Crown cutover data dates from 1976-2001, while FMD 4 ACCC cutover data dates from 1983-1998). Following the approach taken with the *State of the Forest Report* (WNMF 2000) and outlined by Von Mirbach (2000), this thesis was guided by the principles of providing the most up-to-date and accurate information where possible, while aiming to show trends over time. Consequently, each indicator measured was handled differently. Von Mirbach (2000) concludes, "this approach has the significant benefit of reporting the *best* and *most meaningful* information for each indicator; an advantage that significantly outweighs the disadvantage of having inconsistencies between indicators."

Data required for some indicators was unfortunately not available (e.g. a forest site-type map of the study area would provide a useful reference value for measures of area of forest type). In the absence of a forest site-type map of the study area, data on forest site-types from the adjacent Terra Nova National Park was used as a reference value. Data on succession following human-caused disturbance was also problematic. The NFSI (2002) included data on "Not-stocked" sites, the worst succession pattern following disturbance. Unfortunately, the NFSI (2002) does not identify the source of disturbance as human-caused or natural, therefore, this measure presented "noisy" results. Finally, the NFSI (2002) provides only a coarse summary of age-classes at 20-year increments up to a maximum of "80+ years", which is suitable for industry purposes, but does not reveal much detailed information in terms of ecological character. This deficiency in data led one interviewee to conclude that the indicator "Area of forest type by age class" is "valid, but the inventory as it currently exists, doesn't support adequate reporting on it."

6.3.3 – Nature of the research

Problems associated with the research methods, the spatial and temporal scale of some indicators, and data quality, confound, to some degree, interpretation of indicator measures. But it should also be appreciated that research into forest sustainability, which incorporates the viewpoints of different perspectives in the forestry community, rarely if ever realizes conclusive, and definitive findings. Some readers may be concerned that the discussion and interpretation of indicator measures leaves many questions unresolved, and even introduces new questions. To some extent, this is the nature of this field of research. As Von Mirbach (2000) states, "Effort to report definitively and without uncertainty on sustainable forest management is doomed to fail. This should in no way stop us from trying or paralyse us in our tracks, however, since it is these very "failures" that will help to sharpen our thinking, deepen our understanding, guide us in refining our indicators, and ultimately improve our decision-making."

Additional interviews in a group discussion forum, with a larger number of interview subjects, would certainly serve to focus the interpretation results, and provide better understanding of the complex relationship between forest property rights and forest health and biodiversity. Acceptable, credible interpretation of research results in the field of forest sustainability indicator reporting and monitoring can only be realised by way of endorsement of all (or most) parties with an interest in the forest in question. The goal of "accepted interpretation" can only, if ever, be reached through repeated reporting and interpretation exercises, with the goal of continually improving the accuracy of interpretation results.

6.4 – Evaluating the research hypotheses

Three research hypotheses drawn from a literature review were presented in Chapter 2. They are as follows:

Hypothesis 1:

As "companies have no incentive to attempt to produce … non-timber outputs in a positive fashion" (Nelson *et al* 2003, 243), forest biodiversity and ecosystem health are underprovided on forestlands under tenure of Corner Brook Pulp and Paper and Abitibi Consolidated Company of Canada.

Hypothesis 2:

As the "production of non-timber goods and services can only be ensured through direct public intervention backed up by stringent regulations" (Haley and Luckert 1992), forest biodiversity and ecosystem health are maintained similarly on all forestlands (Crown and company-tenured areas) in Newfoundland, due to a forest management regime based on public participation and strict regulations.

Hypothesis 3:

As "resource outcomes will be determined by the actors, their preferences, and the *de facto* institutions operating on the ground" (Gibson *et al.* 2002), any differences in forest biodiversity and ecosystem health in Corner Brook Pulp and Paper forests, Abitibi Consolidated Company of Canada forests, or Crown forests are not a result of the type of property rights *per se.*

Given the complexities involved in interpreting indicator results, evaluation of these three hypotheses is a challenge. Beginning with the first hypothesis, research results indicate that there is no strong evidence to suggest that the pulp and paper companies significantly under-provide for forest biodiversity and ecosystem health in comparison to the Crown. Indicator measures suggest that there may be differences in the relative pressure placed on the land base when comparing companies to the Crown. The area of annual average cutover was nearly two times higher, for example on company land in FMD 5 when compared to Crown land in FMD 5. Similar trends were not evident however in FMD 4 or FMD 6. The area of Not-stocked land was also higher on company lands in FMD 5 than Crown land. But again, there was no trend in FMD 4 or FMD 6. Turning to other indicator measures, CBPP maintained the highest level of suitable marten habitat in relation to total managed forest area in the study area. ACCC ranked highest in area of land relinquished for protected area establishment. Crown land in FMD 5 showed the strongest negative trend in terms of the amount of cleared land. Depending on the indicator measure, different tenure holders have come out ahead of the others, but there is no consistent sign that the companies under-provide for forest health and biodiversity relative to the Crown.

Given the discussion on the first hypothesis, one can deduce that the second hypothesis – all tenure holders similarly maintain forest health and biodiversity – carries more weight than the first. Analysis of the five indicators does not show that any one tenure holder is significantly under-providing for forest health and biodiversity in comparison to another. Measures of forest type by age class reveal that there are more similarities than differences in forest condition of the three tenure holders. Yet, indicator measures reveal that there are differences in *how* tenure holders maintain forest health and biodiversity. Given that the Crown has much less Not-stocked area in FMD 5 than the companies, one can infer that they carry out replanting and silviculture activities more aggressively than the companies. High percentages of average annual cutovers on company lands in FMD 5 indicate that pressure on the land base is not even, or consistent across forest management district boundaries, or tenure boundaries. Similarly, even when looking at lands of a single tenure holder, such as CBPP, maintenance of suitable habitat for Newfoundland Marten can vary significantly across management districts. CBPP has maintained more than twice the amount of suitable habitat for Newfoundland Marten in FMD 5 as compared to FMD 6. As discussed above, this may be accounted for by differences in site condition and natural disturbance history, or cutting intensity, or a mix or both. This second hypothesis – all tenure holders similarly maintain forest health and biodiversity – therefore appears to be accurate when considering results on the spatial scale of the entire study area. Yet results also indicate that there can be significant variance in the maintenance of forest health and biodiversity when inquiry narrows to a forest management district scale. The hypothesis states that forest health and biodiversity are equally maintained across tenure boundaries due to "a forest management regime based on public participation and strict regulations." This research did not address the relative influence of public participation versus regulatory mechanisms in determining forest conditions, but this is an interesting question for future research.

Research results also support the hypothesis that "resource outcomes will be determined by the actors, [and] their preferences." The management orientation of all three tenure holders is very similar, and can be best characterized by the common objective of even-age management, prioritizing cutting of the oldest trees first. Consequently, the overall age class structure of all three tenure holders is more or less similar. Differences in the age class structure between tenure holders (e.g. Crown lands in FMD 5 have the lowest amount of old forest) can be accounted for by differences in natural disturbance history (e.g. the 1961 fire on the Bonavista North Peninsula affected Crown lands in FMD 5 more severely than other tenure holders). Yet, there are differences in the management objectives of tenure holders, which produce measurable differences in forest conditions. Only Crown lands sustain selective cutting by domestic loggers, thus producing pockets of mixed-age class forests. A relatively high percentage of cleared Crown land in FMD 5 is a result of that tenure holder choosing to convert productive forestland to meet the needs of other land users. The preferences and priorities of tenure holders are also revealed in the high percentage of Not-stocked CBPP land in FMD 5. One interviewee commented that FMD 5, at great distance from the CBPP mill, has been a lower priority for replanting when compared to other CBPP lands in closer proximity to the mill. Similarly, results indicate that a tenure holder's decision to support designation of a protected area on their lands is made on a case-by-case basis, depending on the interests and preferences of the tenure holder. The Crown forest ecologist's observation that the three tenure holders tend to "stand together" in negotiating environmental regulations reveals that not only are the preferences of these three actors often closely aligned, but that they work in concert to realize them.

The hypothesis also states that "the *de facto* institutions operating on the ground" will determine resource outcomes. Additional research is required to determine the relative influence of "institutions" such as the public forest planning team for FMDs 4, 5, and 6, in determining resource outcomes.

6.5 – Future reallocation of forest property rights in Newfoundland

The question of the influence of property rights on forest health and biodiversity is a contemporary topic in Newfoundland. In 2005, the timber license for 207,753 hectares of land held by ACCC expired. In 2010, the company's tenure over 965,565 hectares will expire. CBPP's holdings, covering 2 million hectares, will expire in 2037. To date, no decisions have been made on the renewal of any of these tenured areas (Newfoundland and Labrador 2003).

Over the past two decades, a paradigm shift has occurred (and continues to emerge) in national and provincial forest management, from Sustained Yield Management to Sustainable Forest Management (SFM). SFM includes not only consideration of timber, but also forest biodiversity, ecosystem health, soil and water protection, global impacts, socio-economic objectives, as well as public planning protocols inclusive of aboriginal rights and interests (Canadian Council of Forest Ministers 1992a, 1998a, National Forest Strategy Coalition 2003). This new approach to forest management implies that natural resource property rights systems must evolve to consider new management objectives such as the conservation of forest health and biodiversity. Scientific research that examines the relationship between forest property rights and forest health and biodiversity can serve to guide reallocation of property rights, and the development of new property rights frameworks. Providing input into the debate on forest tenure systems is thus a key objective of this research. This thesis is the first research to examine the influence of forest property rights on forest health and biodiversity in Newfoundland.

Research results indicate that factors related to forest property right such as cutting practices, pressure on the land base, land use changes, and proximity to processing facilities can affect forest health and biodiversity. Differences in measures of forest health and biodiversity between tenure holders become more pronounced when analysis is carried out on a small spatial scale (e.g. forest management district scale), yet tend to "even out" when analysing at a larger spatial scale (e.g. the entire study area). This finding is likely a result of the type of indicators selected for this research. Forest health and biodiversity indicators for wide-ranging species such as Woodland Caribou or Newfoundland Marten are better managed over large spatial scales. But this finding also points to the interaction between the forest management district system and forest property rights.

At present, the *Forestry Act* (1990) requires tenure holders to produce an even, sustainable timber supply on a forest management district scale. Such a system is guided by the principle of spreading the economic benefits of woodcutting as evenly amongst communities as possible. But as one interviewee argued, "the indicators that you're using are much better managed over a large landscape." One could therefore argue that a tenure holder could protect larger forest areas, as required by Newfoundland Marten, if the forest management districts were amalgamated, thereby releasing the tenure holder from maintaining a sustainable wood supply district by district. Requiring sustainable wood supply district by district fragments the landbase, which is contrary to marten. The interviewee commented that this is an argument that companies use to support amalgamation of districts. On the flip side, however, they noted that amalgamation of districts would result in the companies becoming more centralized in terms of employment, fewer communities would gain economic benefits from logging, and government would have far less control over where logging takes place. The interviewee concluded that the forest district management system was established in a period where "as long as the cutovers were well-hidden on the landscape, everyone was happy, but that's not necessarily the ecological approach."

Prioritizing the aspects of forest health and biodiversity we wish to monitor and manage for, may therefore influence the future reallocation of forest property rights, or redesign of property rights frameworks. If maintenance of *endangered* Newfoundland Marten and other wide-ranging species is seen to be a priority for forest management, and is being negatively impacted by the forest management framework (i.e. legislation, regulations, policy, and the property rights system), changes to the framework may be required. It has been argued that small sized tenure blocks, for example, can limit the manoeuvrability and flexibility of a tenure holder in designing cutting plans that support sensitive wildlife species such as Newfoundland Marten. More generally, Haeussler and Kneeshaw (2003) argue that large tenure blocks can allow a manager to carry out forest management activities which more closely mimic natural disturbance patterns. They state:

> *The extent to which harvest activities can be modified to more closely mimic the temporal patterns of nature depends on how the landscape is subdivided or amalgamated into forest management units or tenures. A large management unit should, in theory, allow more flexibility to schedule logging*

> *activities so that large-scale disturbances are episodic and portions of landscapes can be left to recover for decades at a time*" (Haeussler and Kneeshaw 2003, 329).

In reallocating forest property rights with a view to assisting recovery of the Newfoundland Marten, decision makers might consider adopting an approach which maximizes the amount of contiguous tenure, while minimizing the amount of small fragmented tenure blocks.

It is the researcher's hope that the indicators, measurement methods, and reference values employed in this research, as well as the indicator measure results, can serve as a reference for future research. There is clearly a need for benchmark studies in order to evaluate forest changes over time. Repeated study using a variety of indicators, at different spatial scales, will improve understanding of the affects of the forest property rights system on forest health and biodiversity in Newfoundland. The Newfoundland Forest Service acknowledges that NFSI (2002) is "not designed to monitor change of defined SFM indicators over time" (Government of Newfoundland and Labrador, 2003, 68). New data sources, designed to track indicators of forest health and biodiversity are therefore urgently needed. Without quality data, it is clear that monitoring of progress towards SFM is compromised.

Effort must also be made to engage all interested parties in sustainable forest management in the endeavour of describing the desired future forest conditions in Newfoundland, and thereby establishing reference values for sustainability monitoring. One of the major impediments to realising SFM goals, as noted by Ross (1995) is that, "even though all [members of the forestry community] concur that minimum standards [for forest sustainability] must be established, disagreements arise about the required level of specificity and constraint, the level of ecosystem "health" to be maintained, and the way in which this "health" may be best achieved" (318). Criteria and indicator monitoring and reporting can serve as a basis for informed decision-making around the possible trade-offs in complex forest management decisions (Natcher and Hickey 2002), such as the reallocation of forest property rights. As this thesis reveals, forest management experts often diverge in their interpretation of indicator measures, and sustainability trends. Renewed investment in a SFM criteria and indicator monitoring program in Newfoundland is therefore recommended as a high priority. If such a program were initiated with the active participation of all parties and individuals interested in forest management, it could be quite helpful in guiding decisions on tenure reallocation that reflect a shared interpretation of current forest conditions and sustainability trends, as well as a collective vision for the future state of Newfoundland forests.

Given that forest tenure policy potentially affects many land users and other (potential) tenure holders, and given that the SFM paradigm strives to incorporate a variety of forest values in decision-making, it would be appropriate for the reallocation of forest property rights in Newfoundland to be carried out through broad consultation with all levels of government, industry, and the public.

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Appendix 1: Background materials and questionnaire provided to participants in scoping interviews

1. Invitation to participate in research

Chris Hogan, M.A. Candidate
Dept. of Geography, Memorial University of Newfoundland
St. John's, NL A1C 5S7

Participants Name
Postal Address

Date

Dear XXXX:

Re: Invitation to participate in research

I request your participation in a research project titled "The Influence of Property Rights on Forest Biodiversity and Forest Health in Northeast Newfoundland." This research is the thesis component of my Masters of Arts degree (Geography) at Memorial University of Newfoundland.

Below you will find an outline of the research objectives, as well as a description of the role you would play if you agree to participate in the study.

Research background and objectives:
The primary research question is: "How do property rights influence forest biodiversity and forest health in Forest Management District 5, Northeast Newfoundland?"

The allocation of property rights over resources is a key component of resource policy and management. The government agency, company, community, or private citizen holding property rights over a resource, usually wields a strong influence in determining its use, distribution of benefits, and the resource's ecological condition.

Forest policy makers in Newfoundland and Labrador must soon make decisions on how to reassign property rights over the Island's forests. In 2005, the timber license for 207,753 hectares of land held by pulp and paper company Abitibi Consolidated Company of Canada expired. In 2010, the company's tenure over all its holdings on the Island, 965,565 hectares, will expire. The tenure of a second pulp and paper company, Kruger Inc., covering 2 million hectares, will expire in 2037. To date, no decisions have been made on the renewal of any of these licenses. As deliberations on future forest tenure options commence, it is of critical importance that an objective assessment of the management performance of the present tenure arrangements is available to policy makers.

The study area for this research will focus on Forest Management District (FMD) 5, located in the Bonavista North area. The study area will be divided into three study plots, corresponding to forest property boundaries within FMD 5. Productive forest in the Crown plot amounts to 112,600 ha (or 1,508,000 m^3 of gross merchantable volume); the Kruger Inc. plot is 56,700 ha (2,155,000 m^3); while the Abitibi plot is 28,600 ha (901,000 m^3).

Step 1: Establish an evaluation framework
The goal of this research is to isolate and understand the relative influence of property rights on forest biodiversity and forest health within FMD 5. Criterion One (Forest Biodiversity) and Criterion Two (Forest Health) of the Canadian Council of Forest Minister's (CCFM) *Sustainable Forest Management Criteria and Indicators* will be used as the evaluation framework for the research.

CCFM Criteria and Indicators 1 and 2 include **sixteen** distinct indicators to measure forest biodiversity and forest health. In the interest of focusing the study, and completing it in a timely manner, the researcher would like to carry out the assessment by measuring only the **five** most relevant indicators. It is at this stage that your assistance is requested.

> **Your role:** You are being asked, along with approximately 10-12 other experts in forest management and forest ecology, to select the top five indicators, which are most relevant to the research question. I propose to gather this information by carrying out individual interviews with each expert, face-to-face whenever possible, otherwise by phone. The interview questions are listed in the attached documentation. *Time commitment: approximately 30-60 minutes.*

Step 2: GIS Analysis
Through data and Geographic Information System (GIS) analysis, the researcher will assess the degree to which the selected indicators are being fulfilled in each study plot (as defined by property boundaries) within FMD 5. The primary data source used to assess each indicator will be the provincial Forest Inventory Stand Data. This database is publicly available from the Newfoundland and Labrador Forestry Branch. Where there are gaps in the database, information will be augmented by other publicly available data from the Newfoundland and Labrador Forestry Branch, and the province's Inland Fish and Wildlife Division.

Step 3: Interpretation of results
In the case of each study plot, the researcher will interpret why certain indicators are being fulfilled, and why others are not being fulfilled. The researcher will explore whether there are extraneous factors, over and above the property rights variable, which influence fulfillment of particular indicators. To assist the analysis, a second round of interviews will be conducted with the experts interviewed in Step 1.

> **Your role:** You will be presented maps and data illustrating each of the five measured indicators for each of the three study plots. You will be asked to help interpret the results and explain why there are any differences between the study plots. Note that at this stage, the researcher will also carry out interviews with

2. Interview questions

1. Newfoundland has two main forms of forest property rights spanning the Island's 18 management districts: a) Crown forest, owned by the people of the province and managed by the Newfoundland and Labrador Forestry Branch; and b) licensed or leased forest, owned by the people of the province, but managed by two pulp and paper companies. In your view, do forest property rights influence forest biodiversity and forest health in Newfoundland? YES / NO. Describe how.

2. The Canadian Council of Forest Ministers (CCFM) has developed an extensive set of indicators to measure forest biodiversity and forest health, but no attempt has been made by the CCFM to weight the relative importance of each indicator. Your assistance is therefore requested to determine the most important indicators. From the following list of sixteen indicators (see Appendix 1 below), **rank the five most important indicators of forest biodiversity and forest health, with "1" indicating the most important.**

3. Rank the top **five** indicators for forest biodiversity and forest health, which are most **directly influenced** or **affected by** the two alternative property rights arrangements.

4. Please provide a brief explanation for why you have selected the five indicators listed in response 3.

5. Are there other, more relevant indicators not included in the CCFM list, which should be considered?

6. Focusing on FMD 5, the study area, does the ranking offered in response 3 still apply, or would you offer a different ranking?

7. Using the information gathered from these interviews, I will assess the degree to which the different tenure holders in FMD 5 fulfill the requirements of the 5 selected indicators. Would you be willing to participate in a second interview (in 6-8 weeks) to review and help interpret the preliminary findings?

8. Other comments / thoughts on this research?

Thank you kindly for your time.

3. List of Criteria and Indicators for Forest Sustainability

Appendix 1: Criteria and Indicators for Forest Sustainability

Excerpt from: Western Newfoundland Model Forest Inc. 1999. *Criteria and Indicators of Sustainable Forest Management: A practical guide to using local level indicators in Newfoundland and Labrador*, Corner Brook, NL: Western Newfoundland Model Forest.

CRITERION ONE: BIODIVERSITY

Conservation of Biological Diversity

CCFM definition: *The variability among living organisms from all ecological complexes of which they are part, including:*

- *ecosystem diversity* (values: representative landscapes, special places)
- *species diversity* (values: wildlife habitat, native and valued species)
- *genetic diversity* (value: native and valued species)

Biodiversity refers to the variety of organisms that are found within our forest. In recent years forest ecologists have become increasingly aware that different species do not exist on their own, but rather are part of a holistic web of interconnections. Biodiversity, therefore, is the basic foundation for all life, including human life. The elements of biodiversity - individual plants, animals, species and ecosystems - have been likened to the rivets on an airplane wing. You might be able to lose a few rivets and the plane may still fly, but if enough rivets are lost then the plane and everyone in it will crash.

A) Value: Representative landscapes

Goal: Establish protected areas[32] that provide adequate representation of each eco-region.

Indicators:

i. Proportion of each eco-region that is in a protected status. (District/Provincial)
ii. Proportion of each eco-region that is barren, bog, forest and water. (District/Provincial)
iii. Proportion of each protected area that is barren, bog, forest and water. (District/Provincial)

Note: When measuring these indicators at the local level, it may be more practical and meaningful to report on the entire eco-region, rather than simply the portion that lies within a particular district.

[32] "Protected area" is defined in this document as an area with legislated restrictions to limit human impact, including prohibitions on logging, hydroelectric developments and mineral or hydrocarbon exploration and development.

B) Value: Special places
- rare plant sites
- important nesting or staging areas
- areas of particularly high wildlife concentration
- pristine areas

Goal: Establish protected areas or special management provisions to preserve biologically distinctive or unique features.

Indicators:

iv. Proportion of unique features identified in the Natural Areas System Plan[33] that are protected or subject to special management provisions. (Provincial)

Useful Information:
- Unique or distinctive biological features. (District)
- Efforts being made to preserve these features (e.g., legislation, policy, stewardship agreements, special projects). (District/Local/Province)

C) Value: Wildlife habitat
Goal: Maintain, conserve and protect habitat for wildlife.

Indicators:

v. Area of each forest type by age class. (District/Provincial)

vi. Area of suitable habitat for selected species (including consideration of factors such as connectivity, fragmentation and existence of features such as snags, coarse woody debris, etc). (District/Provincial)

Useful Information:
- Permanent landscape changes that affect wildlife habitat. (District/Provincial)

Note: "Selected Species" has not been defined here, but should focus on species that play a particularly significant role, as indicator species, umbrella species, keystone species, etc.

D) Value: Native and valued species
Goal: Maintain viable populations of native and other valued species.[34]
Goal: Maintain genetic diversity of populations of native species.
Goal: Protect and enhance the populations of species at risk.

Indicators:

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[33] This is not yet a public document.

[34] Examples of species that are "valued" but not native to the Island include moose and snowshoe hare.

vii. Known forest-dependent species classified as extinct, extirpated, endangered, threatened and vulnerable on national, provincial and local lists, including:
    a. Change in risk status of species.
    b. Change in numbers of individuals for each species at risk. (District/Provincial)

viii. Change in population level or ranges of selected species. (District/Provincial)

ix. Genetic information (such as genetic diversity or inbreeding levels) about selected species. (Provincial)

x. Reproductive success or fecundity of selected species (eg. cow-calf ratio for moose and caribou; percentage of sufficiently restocked areas for softwood tree species). (Provincial)

Note: *"Species"* can include animals, fish, insects, trees, shrubs, flowers, lichens, micro-organisms, etc.

CRITERION TWO: HEALTHY FORESTS

Maintenance and Enhancement of Forest Ecosystem Condition and Productivity
CCFM definition: *The health, vitality and rates of biological production in forest ecosystems, including:*

- *Incidence of disturbance and stress (biotic and abiotic)* (value: natural processes)
- *Ecosystem resilience* (value: natural resilience)
- *Extant biomass (biota)* (value: natural productive capacity)

This criterion deals with maintaining the health, vitality and productivity of the forest and all its components. A healthy forest is not a static, unchanging forest – in fact, natural disturbances are a vital part of forest ecosystems, so that while insects, fires and storms may damage or kill some trees, that doesn't necessarily mean that they are harming the forest as a whole. We do know that a healthy forest is a productive forest, with constant new growth of trees, other plants and animals. A healthy forest is also resilient, meaning that it can deal with change and disturbance without losing its fundamental productivity. Human activities, if not carefully managed, can add to the stresses that a normal forest ecosystem experiences, to the point that productivity and resilience starts to decline.

A) Value: Natural Processes

- succession trends
- population fluxes
- natural disturbances (insects, disease, fire, etc)
- nutrient cycling
- resiliency

Goal: Support the ecosystem's ability to maintain natural processes.

Indicators:

xi. Area and severity of insect, fire and disease disturbance, and succession pattern afterwards. (District/Provincial)

xii. Area and severity of human-caused disturbances (e.g., logging, air pollution, species introduction), and succession pattern afterwards. (District/Provincial)

xiii. Frequency, abundance and distribution of selected indicator species relative to natural cycles. (District/Provincial)

Useful Information:

- Information about the introduction of introduced plant and animal species, and the impacts that these introductions are having. (District/Provincial)

B) Value: Natural Productive Capacity

- trees and plants
- animals

Goal: In areas that are managed for timber production, maintain and/or enhance the structure, function and productivity of ecosystem components.

Indicators:

xiv. Mean Annual Increment (MAI). (District/Provincial)

xv. Reproductive success or fecundity of selected species. (Provincial)

xvi. Land use changes, changes to total area of forest cover. (District/Provincial)

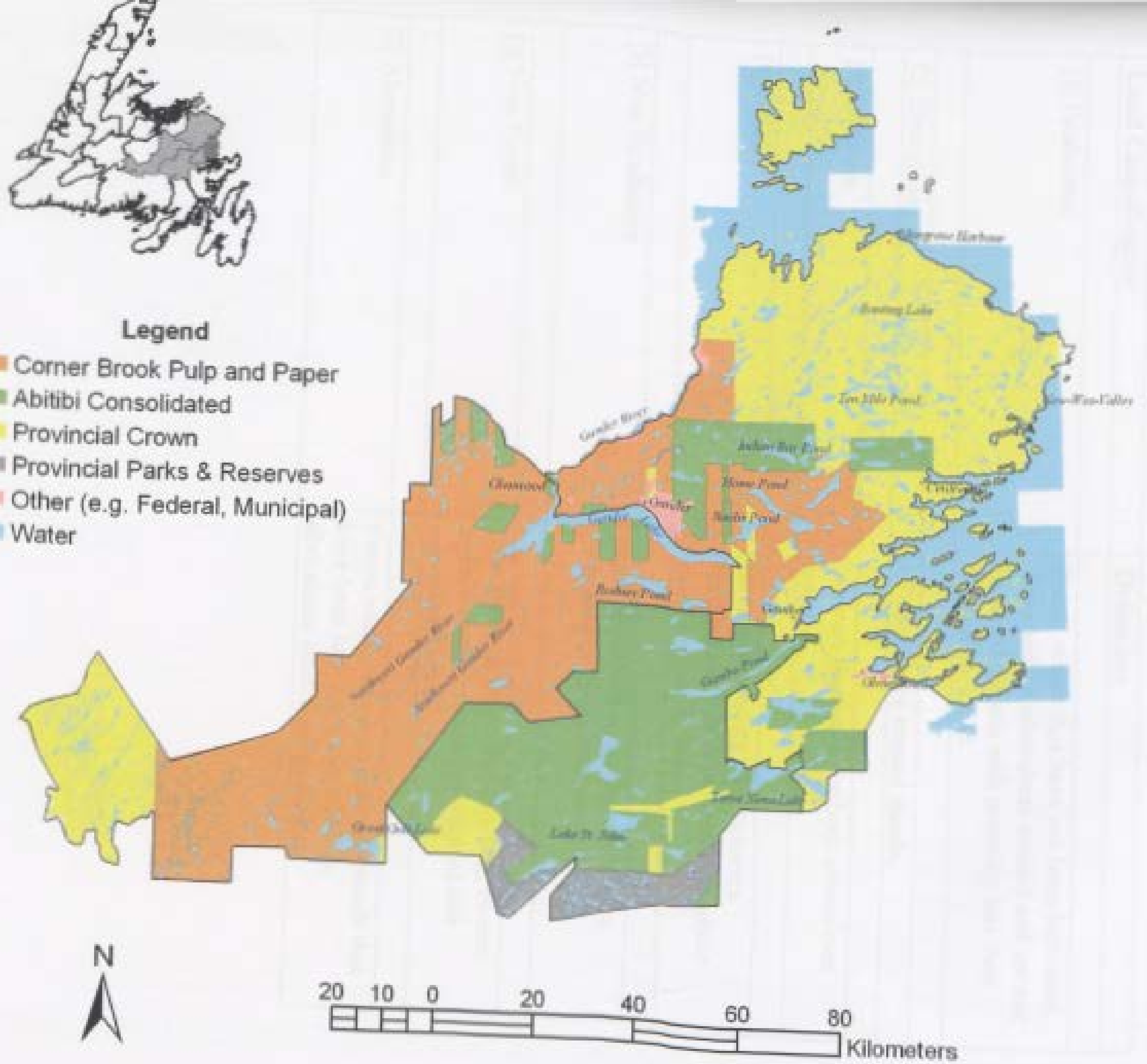
C) Value: Long-term ecosystem health

Goal: Maximize the resiliency of the province's forests (including soils and peat lands) in the light of current climate change predictions and scenarios

Useful Information:

- Information about provincial strategies to respond to the management challenges posed by global climate change. (Provincial)

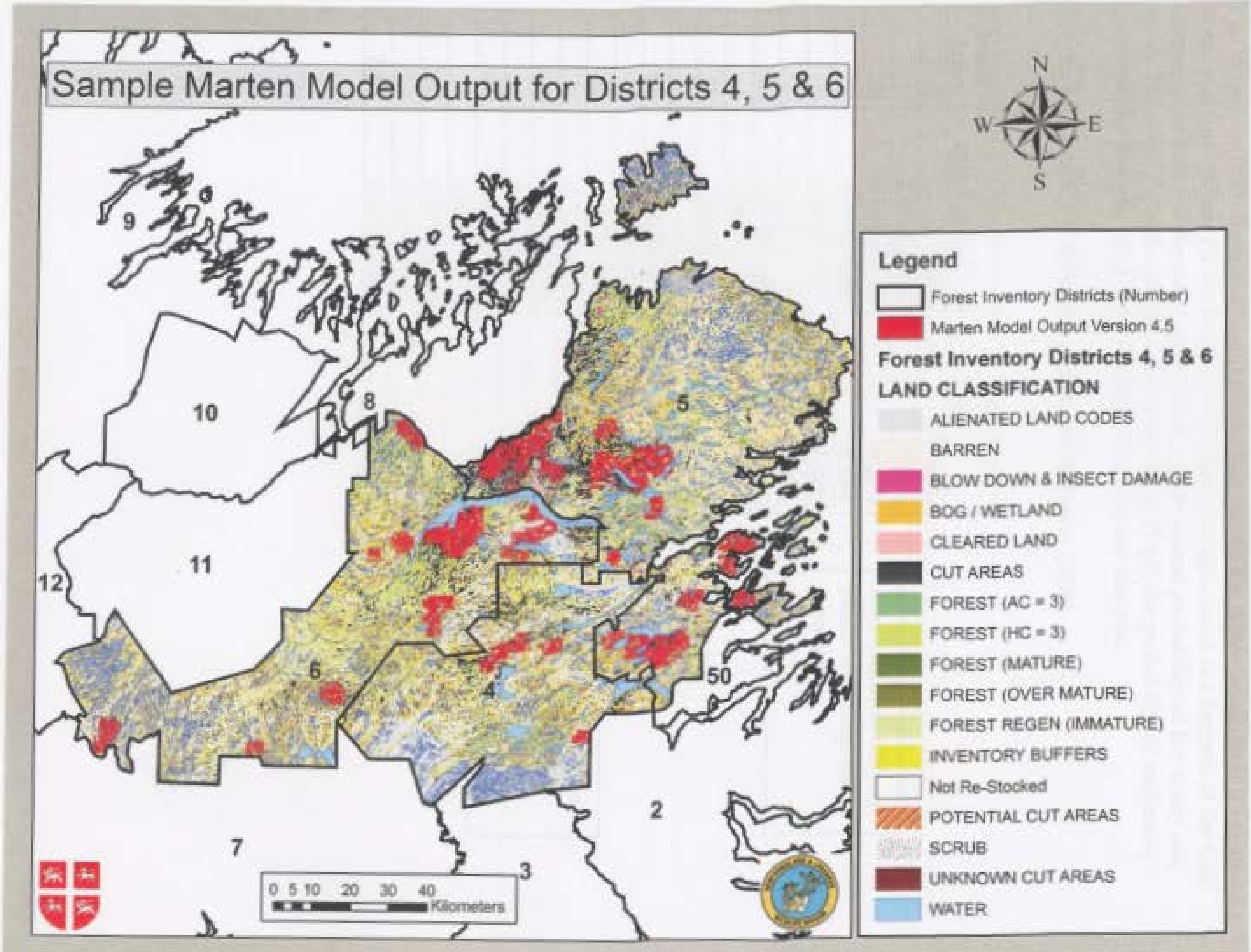
Note: "Long-term" here is meant to apply to time frames equal at a minimum to twice the average life expectancy of the predominant tree species.



Appendix 2: Study area including selected place names and water body names

Appendix 3: Definitions for land classifications of the Newfoundland Forest Stand Inventory (Excerpted from *Data Dictionary for District Library,* Department of Natural Resources, Forestry Branch).

Land Classification	**Definition**
[1] Productive	Forest stands that have not been harvested, disturbed, or silviculture treated and are not alienated. Stands with mortality less than 50% are included.
[2] Silviculture	All silviculture treated stands.
[3] Cutovers	Cutovers that have not been silviculture treated
[4] ODIS	Disturbances other than cutovers. Disturbances that have been silviculture treated are not included.
[5] Non Productive	Scrub. Excludes scrub that have been disturbed or silviculture treated.
[6] Non Forest	Non forested areas. Includes bog, barren, rights-of-ways, cleared, residential and agricultural land.
[7] Alienations	Forest stands that are alienated. Stands that have been harvested, disturbed, or silviculture treated are excluded.



Appendix 4: Sample Suitable habitat map for Newfoundland Marten (Source, Wildlife Division, 2005).

Appendix 5: Expected theoretical age class distribution for Terra Nova National Park and surrounding region

Van Wagner's (1978) theoretical age class distribution for fire driven ecosystems is expressed as $f(x) = p(1\text{-p})^x$. Where f is the frequency of single-year age-classes as a fraction of the total number of stands; x is the stand age in years; p is the annual probability of fire in any one stand. Therefore $f(x)$ is the product of two terms: (1) $(1\text{-p})^x$, the probability of successive years without fire, and; (2) p, the probability of fire in any one year.

For this calculation, $p = 0.01024$ as calculated by Power (1996).

Stand Age	$F(x) = p(1-p)^x$	%
0	0.01024	11.05%
	0.009238446	9.97%
20	0.008334853	9.00%
	0.007519638	8.12%
40	0.006784157	7.32%
	0.006120612	6.61%
60	0.005521968	5.96%
	0.004981875	5.38%
80	0.004494608	4.85%
	0.004055	4.38%
100	0.003658388	3.95%
	0.003300569	3.56%
120	0.002977747	3.21%
	0.002686499	2.90%
140	0.002423738	2.62%
	0.002186677	2.36%
160	0.001972803	2.13%
	0.001779847	1.92%
180	0.001605764	1.73%
	0.001448707	1.56%
200+	0.001307012	1.41%

Approximately 63% of stands are young and regenerating.

Approximately 37% of stands are old (80+ years).

Appendix 6: Corner Brook Pulp and Paper Age Class Structure by Working Group

		FMD 4		FMD 5		FMD 6		TOTALS	
Working group	Age Class	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
bF	1	0	--	1,863	81%	10,063	76%	11,925	76%
	2	0	--	296	13%	2,868	22%	3,163	20%
	3	0	--	28	1%	45	0%	72	0%
	4	0	--	48	2%	42	0%	90	1%
	5	0	--	70	3%	275	2%	344	2%
	9	0	--	0	0%	0	0%	0	0%
		0	--	2,304	100%	13,292	100%	15,596	100%
bS	1	0	--	781	3%	27,163	27%	27,944	22%
	2	0	--	7,593	26%	20,972	21%	28,564	22%
	3	0	--	2,462	9%	3,165	3%	5,627	4%
	4	0	--	14,224	50%	4,380	4%	18,605	14%
	5	0	--	3,651	13%	44,649	44%	48,300	37%
	8	0	--	0	0%	0	0%	0	0%
	9	0	--	3	0%	32	0%	35	0%
		0	--	28,714	100%	100,361	100%	129,075	100%
hS	1	0	--	65	2%	17	1%	82	1%
	2	0	--	313	10%	955	35%	1,267	21%
	3	0	--	68	2%	221	8%	290	5%
	4	0	--	1,789	56%	606	22%	2,395	41%
	5	0	--	934	29%	939	34%	1,873	32%
	9	0	--	0	0%	0	0%	0	0%
		0	--	3,168	100%	2,738	100%	5,907	100%
sH	1	0	--	124	3%	1,692	27%	1,815	18%
	2	0	--	506	13%	2,814	45%	3,320	33%
	3	0	--	106	3%	532	9%	637	6%
	4	0	--	2,544	67%	467	7%	3,011	30%
	5	0	--	541	14%	745	12%	1,286	13%
	9	0	--	1	0%	0	0%	1	0%
		0	--	3,821	100%	6,249	100%	10,070	100%
wB	1	0	--	0	0%	5	0%	5	0%
	2	0	--	7	0%	373	12%	380	6%
	3	0	--	6	0%	289	10%	295	4%
	4	0	--	2,254	61%	643	21%	2,897	43%
	5	0	--	1,425	39%	1,709	57%	3,134	47%
	9	0	--	0	0%	0	0%	0	0%
		0	--	3,692	100%	3,019	100%	6,711	100%
tA	1	0	--	0	0%	0	0%	0	0%
	2	0	--	2	3%	6	7%	8	5%

	3	0	--	0	0%	0	0%	0	0%
	4	0	--	26	36%	16	17%	43	25%
	5	0	--	44	61%	72	76%	116	70%
		0	--	73	100%	94	100%	167	100%
eS	1	0	--	0	--	0	--	0	--
	2	0	--	0	--	0	--	0	--
	3	0	--	0	--	0	--	0	--
	4	0	--	0	--	0	--	0	--
	5	0	--	0	--	0	--	0	--
		0	--	0	--	0	--	0	--
jP	1	0	--	0	--	0	0%	0	0%
	2	0	--	0	--	2	100%	2	100%
	3	0	--	0	--	0	0%	0	0%
	4	0	--	0	--	0	0%	0	0%
	5	0	--	0	--	0	0%	0	0%
		0	--	0	--	2	100%	2	100%
sS	1	0	--	0	--	0	--	0	--
	2	0	--	0	--	0	--	0	--
	3	0	--	0	--	0	--	0	--
	4	0	--	0	--	0	--	0	--
	5	0	--	0	--	0	--	0	--
		0	--	0	--	0	--	0	--
DI		0		66		582		648	
NS		0		4,737		4,556		9,293	

Appendix 7: Abitibi Consolidated Company of Canada Age Class Structure by Working Group

		FMD 4		FMD 5		FMD 6		TOTALS	
Working group	Age Class	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
bF	1	1,699	33%	1,010	88%	421	57%	3,130	44%
	2	2,229	43%	35	3%	312	42%	2,577	36%
	3	295	6%	13	1%	0	0%	308	4%
	4	429	8%	26	2%	4	0%	459	6%
	5	534	10%	67	6%	1	0%	603	9%
	9	0	0%	0	0%	0	0%	0	0%
		5,187	100%	1,151	100%	738	100%	7,076	100%
bS	1	9,957	17%	1,181	8%	1,180	15%	12,318	15%
	2	12,002	21%	3,162	21%	4,021	51%	19,185	24%
	3	9,058	16%	663	4%	857	11%	10,578	13%
	4	4,147	7%	7,715	52%	771	10%	12,633	16%
	5	21,864	38%	2,227	15%	1,122	14%	25,214	32%
	8	0	0%	4	0%	0	0%	4	0%
	9	12	0%	0	0%	0	0%	12	0%
		57,040	100%	14,954	100%	7,951	100%	79,945	100%
hS	1	6	1%	14	1%	34	4%	54	2%
	2	115	11%	328	34%	453	54%	896	31%
	3	16	1%	160	17%	42	5%	217	8%
	4	395	36%	387	40%	164	20%	946	33%
	5	559	51%	73	8%	146	17%	777	27%
	9	0	0%	0	0%	0	0%	0	0%
		1,091	100%	961	100%	839	100%	2,891	100%
sH	1	43	3%	35	2%	24	2%	102	2%
	2	231	15%	903	44%	539	46%	1,672	35%
	3	31	2%	66	3%	391	33%	488	10%
	4	546	35%	902	44%	169	14%	1,616	34%
	5	694	45%	154	7%	59	5%	907	19%
	9	8	1%	5	0%	0	0%	12	0%
		1,553	100%	2,065	100%	1,180	100%	4,798	100%
wB	1	66	7%	0	0%	0	0%	66	3%
	2	120	12%	32	5%	101	26%	253	13%
	3	31	3%	67	11%	37	10%	134	7%
	4	174	18%	404	67%	203	53%	781	40%
	5	589	60%	97	16%	43	11%	729	37%
	9	0	0%	0	0%	0	0%	0	0%
		979	100%	601	100%	384	100%	1,963	100%
tA	1	0	0%	0	0%	0	0%	0	0%

	2	0	0%	5	46%	14	57%	19	31%
	3	0	0%	4	33%	6	25%	10	16%
	4	17	68%	0	0%	4	18%	21	35%
	5	8	32%	2	21%	0	0%	10	17%
		25	100%	12	100%	24	100%	60	100%
eS	1	0	0%	0	--	0	--	0	0%
	2	9	100%	0	--	0	--	9	100%
	3	0	0%	0	--	0	--	0	0%
	4	0	0%	0	--	0	--	0	0%
	5	0	0%	0	--	0	--	0	0%
		9	100%	0	--	0	--	9	100%
jP	1	0	0%	0	--	0	--	0	0%
	2	20	100%	0	--	0	--	20	100%
	3	0	0%	0	--	0	--	0	0%
	4	0	0%	0	--	0	--	0	0%
	5	0	0%	0	--	0	--	0	0%
		20	100%	0	--	0	--	20	100%
sS	1	0	0%	0	--	0	--	0	0%
	2	2	100%	0	--	0	--	2	100%
	3	0	0%	0	--	0	--	0	0%
	4	0	0%	0	--	0	--	0	0%
	5	0	0%	0	--	0	--	0	0%
		2	100%	0	--	0	--	2	100%
DI		581		138		33		751	
NS		3,757		2,631		361		6,749	

Appendix 8: Crown Age Class Structure by Working Group

			FMD 4			FMD 5			FMD 6			TOTALS	
Working group	Age Class		Area (ha)	%		Area (ha)	%		Area (ha)	%		Area (ha)	%
bF	1		83	87%		4,169	54%		19	28%		4,270	54%
	2		0	0%		365	5%		0	0%		365	5%
	3		3	3%		444	6%		0	0%		447	6%
	4		0	0%		1,026	13%		0	0%		1,026	13%
	5		10	10%		1,249	16%		49	72%		1,307	17%
	9		0	0%		495	6%		0	0%		495	6%
			95	100%		7,747	100%		67	100%		7,909	100%
bS	1		610	28%		2,634	5%		204	3%		3,448	5%
	2		0	0%		21,932	40%		0	0%		21,932	34%
	3		413	19%		3,069	6%		0	0%		3,482	5%
	4		36	2%		16,429	30%		92	1%		16,557	26%
	5		1,084	51%		10,510	19%		7,437	96%		19,032	29%
	8		0	0%		1	0%		9	0%		10	0%
	9		0	0%		269	0%		0	0%		269	0%
			2,144	100%		54,844	100%		7,742	100%		64,730	100%
hS	1		0	0%		32	0%		0	0%		32	0%
	2		0	0%		5,606	65%		0	0%		5,606	63%
	3		0	0%		693	8%		0	0%		693	8%
	4		0	0%		1,541	18%		77	27%		1,618	18%
	5		8	100%		739	9%		205	73%		951	11%
	9		0	0%		17	0%		0	0%		17	0%
			8	100%		8,627	100%		282	100%		8,917	100%
sH	1		0	0%		287	2%		0	0%		287	2%
	2		0	0%		8,770	54%		0	0%		8,770	52%
	3		0	0%		1,469	9%		0	0%		1,469	9%
	4		0	0%		4,504	28%		3	0%		4,506	27%
	5		6	100%		1,285	8%		540	100%		1,830	11%
	9		0	0%		24	0%		0	0%		24	0%
			6	100%		16,338	100%		543	100%		16,886	100%
wB	1		0	0%		30	1%		3	5%		33	1%
	2		0	0%		1,098	38%		1	2%		1,100	37%
	3		0	0%		196	7%		7	11%		202	7%
	4		0	0%		781	27%		24	41%		805	27%
	5		1	100%		781	27%		24	41%		806	27%
	9		0	0%		12	0%		0	0%		12	0%
			1	100%		2,898	100%		59	100%		2,959	100%
tA	1		0	--		0	0%		0	0%		0	0%
	2		0	--		558	85%		0	0%		558	85%

	3		0	--		26	4%		0	0%		26	4%
	4		0	--		50	8%		0	0%		50	8%
	5		0	--		22	3%		3	100%		25	4%
			0	--		656	100%		3	100%		659	100%
eS	1		0	--		0	--		0	--		0	--
	2		0	--		0	--		0	--		0	--
	3		0	--		0	--		0	--		0	--
	4		0	--		0	--		0	--		0	--
	5		0	--		0	--		0	--		0	--
			0	--		0	--		0	--		0	--
jP	1		0	--		0	--		0	--		0	--
	2		0	--		0	--		0	--		0	--
	3		0	--		0	--		0	--		0	--
	4		0	--		0	--		0	--		0	--
	5		0	--		0	--		0	--		0	--
			0	--		0	--		0	--		0	--
sS	1		0	--		0	--		0	--		0	--
	2		0	--		0	--		0	--		0	--
	3		0	--		0	--		0	--		0	--
	4		0	--		0	--		0	--		0	--
	5		0	--		0	--		0	--		0	--
			0	--		0	--		0	--		0	--
DI			0			33			0			33	
NS			37			2,595			25			2,657	

Appendix 9: Protected areas by name, area, and percentage of ecoregion/subregion

Ecoregion / subregion	Total size (ha)	Protected areas	Area within ecoregion / subregion (ha)	% of ecoregion / subregion
Northcentral subregion	2,310,742	Sir Richard Squires Memorial Provincial Park	1,574	0.07%
		Flatwater Pond Provincial Park	87	0.00%
		West Brook Ecological Reserve	1,074	0.05%
		Jonathon's Pond Provincial Park	503	0.02%
		Notre Dame Provincial Park	113	0.00%
		Bay du Nord Wilderness Reserve	2,716	0.12%
		T'Railway Provincial Park	1,182	0.05%
		Terra Nova National Park	28,067	1.21%
			35,315	1.53%
North Shore forest ecoregion	550,662	Dildo Run Provincial Park	328	0.06%
		Terra Nova National Park	13,422	2.44%
			13,749	2.50%
Central Barrens subregion	1,524,393	Bay du Nord Wilderness Reserve	270,379	17.74%
Eastern Hyper-Oceanic Barrens ecoregion	160,335	Deadman's Bay Provincial Park	77	0.05%
		Windmill Bight Provincial Park	353	0.22%
		Baccalieu Island Ecological Reserve	634	0.40%
		Mistaken Point Ecological Reserve	295	0.18%
		Chance Cove Provincial Park	1,809	1.13%
		Cape St. Mary's Ecological Reserve	1,234	0.77%
			4,401	2.75%
TOTALS	4,546,132		323,845	7.12%

Appendix 10: Newfoundland Tenure Distribution in 1960 (Source: Munro 1978)