GPI Atlantic

Genuine Progress Index for Atlantic Canada / Indice de progrès véritable - Atlantique

MEASURING SUSTAINABLE DEVELOPMENT

APPLICATION OF THE GENUINE PROGRESS INDEX TO NOVA SCOTIA

THE NOVA SCOTIA GENUINE PROGRESS INDEX FOREST ACCOUNTS

VOLUME 1
INDICATORS OF ECOLOGICAL, ECONOMIC & SOCIAL VALUES OF FORESTS IN NOVA SCOTIA

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"How can we know with any confidence whether efforts to stem forest decline, are having a positive effect? How can we track what is happening to the forest capital over time? How can we get away from measuring systematic depletion of the forest resource as a net gain in economic growth? If indeed we value forests as an asset, and if ensuring the ability of future generations to meet their own needs is not just rhetoric, it would be useful... to appraise the effectiveness over time of all that we do in relation to sustaining forests. We need a measure for the changing value of the forest capital of the world."

World Commission on Forests and Sustainable Development 1999

Unfortunately, [GDP figures] are generally used without the caveat that they represent a value that cannot be sustained. Current calculations ignore the degradation of the natural resource base and view the sales of nonrenewable resources entirely as income. A better way must be found to measure the prosperity and progress of mankind.

Barber C. Conable, former President of the World Bank, 1989

In calculating GNP, natural resources are not depreciated as they are used up....For all practical purposes, GNP treats the rapid and reckless destruction of the environment as a good thing!...The world community, led by the United States, should move to change this widely used formulation and others like it that badly mislead decision-makers who might otherwise place more appropriate economic values on the protection of the global environment.

Al Gore, former Vice-President, U.S.A.[1]

[1] References for Conable and Gore statements provided by Redefining Progress, which produced the first U.S. GPI. 1904 Franklin Street, 6th floor, Oakland, Ca. 94612, USA; www.rprogress.org

PREFACE

Our conventional economic accounts, based on the Gross Domestic Product and on economic growth statistics, mistakenly count the depletion of our natural resources as economic gain. The more trees we cut down and the faster we cut them down, the more the economy will grow, and the "better off" we think we are. Our standard measures of economic health, including assessments of the contribution of the forest sector to the economy, only account for the value of the felled timber. They do not account for the value of what remains in the forest (our natural wealth), nor for depreciation in the value of these natural capital assets. The need for better measures of progress and economic well-being is now universally acknowledged.

On the other hand, accounting accurately for the health of our natural resource stocks, and for the value of the services they provide, is a daunting task. Enormous challenges exist in identifying and interpreting inadequate, widely scattered and inconsistent data, in assessing trends over long periods of time (like the successional cycle of forests), in valuing non-market services, in developing appropriate methodologies, and in applying the results to policy measures that can enhance the value of our natural resource wealth.

The GPI Natural Resource Accounts for Nova Scotia are the first set of natural resource accounts for any jurisdiction in Canada. Inevitably, the first attempts to account systematically for the health of our natural capital assets raise numerous questions for every answer they attempt to provide. This is as it should be, and the authors wish to begin by declaring five major limitations of their work forthrightly:

1) Despite four years of research into these GPI Forest Accounts, the work has only just begun. There is no pretence that these accounts, nor the Genuine Progress Index as a whole, are a final product in any way. GPI Atlantic welcomes improvements in data sources, methodologies, analysis, and interpretation that will allow corrections and more accurate updates and assessments in the future.

2) These forest accounts were generously reviewed by nearly 30 expert reviewers, including government officials, foresters, scientists, and academics. GPI Atlantic has amassed more than 100 tightly-knit pages of detailed line-by-line commentary from these reviewers. The authors have done the best they could, given severe financial, resource, data, and time constraints, to examine each of these comments to the extent possible. In many cases, the comments led to further research, corrections, and the incorporation of new information into these accounts.

   However, there are also many important comments that require more research and further analysis, which time and money simply did not allow. GPI Atlantic would be delighted to work cooperatively with other researchers who have an interest in following up on the many important leads contained in these comments, and thereby to improve and update these forest accounts.

3) GPI Atlantic's goal is to provide a full economic valuation of Nova Scotia's forests, including estimates of standing stock values, of depreciation, and of the value of services provided by the

forests. We did not achieve this comprehensive goal with these forest accounts, although we have attempted to point towards economic values wherever possible. This is largely because inadequate time series data were available on the *physical* health of the province's forests. These data are the essential basis for any economic valuation.

GPI economic valuations are always based on a prior set of physical accounts. For example, GPI Atlantic's economic "Cost of Crime" study is based on crime rates; "The Economic Value of Voluntary Work" study is based on the amount of time volunteers contribute; "The Cost of Tobacco" and "Cost of Obesity" studies are based on prevalence rates for smoking and obesity related illnesses; and so on.

But these physical data were not easily available for our forests. For example, changes in the age structure of Nova Scotia's forests, a vital indicator of forest health, have never before been published or publicly released as a trend over time, and are revealed for the first time in these accounts. For this reason, most of the research effort of the last four years has gone into a compilation and assessment of the basic, available physical data, while the economic assessments in these accounts remain rudimentary and in great need of further work in future updates.

Some important data are simply not available, and will require field and laboratory tests before any assessments – physical or economic – can be made. For example, soil tests are needed to assess the impacts of different harvest methods on soil organic matter and nutrient content, and on erosion, over successive harvest cycles, knowledge which is vital to estimate impacts on timber productivity, future wood supply, and forest health.

The GPI Atlantic approach is to base any comprehensive economic valuation on a thorough understanding and separate valuation of each of the component parts, to the extent possible. The full valuation of Nova Scotia's forest values, therefore, is still being built from the bottom up. Nevertheless, these accounts do attempt to identify major data gaps, and to point towards future data needs. They will hopefully stimulate the necessary research, so that future updates will be more accurate and comprehensive.

4) These two volumes badly need a good edit, which financial resources at time of publication did not allow. These accounts should be about one-third their present length! Part of the problem is in the particular approach adopted for these accounts, which value each forest function in turn. This lends itself to considerable repetition, as some evidence, like age structure for example, is an indicator of effectiveness for several different forest functions.

   The fundamental approach of the GPI natural resource accounts as a whole is to assess the health of a resource in accordance with its capacity to perform all of its functions optimally and effectively. Thus, a healthy forest is one that protects soils, watersheds, biodiversity, and habitat for wildlife; regulates the climate; sequesters carbon from the atmosphere; and provides timber, employment, recreational opportunities, and other services to human society. The case studies in Volume 2 adhere to this approach and framework, and repeat many of the results from Volume 1, in order to illustrate the extent to which sustainable harvesting practices protect and promote the capacity of forests to perform their varied functions more effectively than under current management systems.

This approach has led to considerable inelegance in the presentation. Because we are still at an early stage in the development of natural resource accounts, GPI Atlantic has opted for repetition at the expense of elegance, in order to retain transparency in presenting the specific evidence and methodologies on which all conclusions are reached. This inelegance and repetition are exacerbated by efforts to combine the work of several researchers over a long period of time, and by a shortage of resources to devote to necessary editing.

For all these reasons and more, this is very much still a work in progress. Despite these major limitations, they should not be taken as a reason for inaction in the policy arena. There is sufficient information in these two volumes to provide concrete guidance for policy makers across a number of dimensions.

The development of these resource accounts is by no means an isolated initiative, or the only necessary step towards more sustainable forest management. The new Maritime Regional Standards of the Forest Stewardship Council, for example, provide a tracking system at the individual woodlot level that matches many of the criteria and indicators in this study.

The woodlot owners profiled in Volume 2, and many others, are already demonstrating practical ways forward towards restoring the value of Nova Scotia's forests, that can be a model for other foresters. The Nova Forest Alliance's model forest program, and the NS Department of Natural Resource's new Registry of Buyers and Forest Sustainability Regulations, particularly the new silviculture credit program that for the first time recognizes and supports selection harvest methods, also have the potential to advance sustainability. In short, the GPI Forest Accounts should quickly become part of a province-wide effort to restore the capacity of our forests to perform all their manifold functions optimally.

In fact, with these measures as a tool to assess progress towards greater forest health, Nova Scotia is in a unique position to take a leadership role in moving the forestry sector towards more sustainable methods of management. Nova Scotia can literally provide a model for the world in restoring the health and value of its forested natural wealth. With all their limitations and need for further research, the results that follow are presented in that spirit – as a practical policy tool for Nova Scotians to create a better world for their children and for future generations, who will inherit the forested wealth of this province.

EXECUTIVE SUMMARY

Nova Scotia today only contains remnants of the mature and old-growth forests that historically were present in the province. A long history of high-grading (removing the best trees), land clearing, and clearcutting over more than two centuries has severely degraded the province's forested natural wealth. The ecological integrity, health, and economic value of Nova Scotia forests have continued to decline sharply since the 1950s, when the Department of Lands and Forests inventory noted that the quality of the province's forests had already decreased substantially.[2]

Major losses in age-class diversity have occurred since the 1950s, with an increasing percentage of forests in younger age classes, and the loss of almost all the province's older forests. In 1958, forests more than 80 years old covered 25% of the province's forest area. Today they cover only 1% of forest area. Forests more than 100 years old covered 8% of the province's forest area in 1958; today they cover only 0.15% of forested land.

True old-growth forest in Nova Scotia is endangered and exists only in very small, scattered, isolated pockets in the province. We are currently witnessing the disappearance of the natural site-evolved species, structure, and age characteristics of the once dominant Acadian forests.

Natural species diversity[3] has also declined with a particularly sharp decline among some tolerant hardwood species. According to forest inventories, merchantable oak, beech, and yellow birch, for example, have all declined significantly.[4] Black ash, of great cultural importance to the Mi'kmaq, is now rare in Nova Scotia. Among softwoods, eastern hemlock has seen a particularly sharp recent decline, down by more than half since 1958 alone. In the early 1900s, 300-year-old stands of eastern hemlock were common in Nova Scotia, with many trees up to 800 years old. White and red pine occupy less than 50% of their former range in this region (CCFM 1997).

The rate of cutting in Nova Scotia has doubled over the past two decades by *volume*, and in the last decade alone the actual *area* clearcut annually has doubled, placing additional stress on the province's forests. The wood volume harvested annually grew from an average of 3.3 million cubic metres between l981 and l985 (NSDNR l997) to 6.5 million m^3 in 2000 (NSDNR 2001).[5] Ninety-nine percent of this wood is harvested by clearcutting. Based on the annual growth rate of the province's forests, on the rate of seeding and planting in the past decade, and on changes in age structure and species composition, the current annual rate of cutting is unsustainable.

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[2] Ken Snow, Manager, Forest Inventory, NSDNR, (2001) notes that the 1958 forest inventory report by Hawboldt and Bulmer. 1958. *The Forest Resources of Nova Scotia*, refers specifically to the reduction of saw log timber. The 1958 report notes that Nova Scotia had lost most of its primary forest, increased the land covered with non-commercial or low-value species, and suffered greater damages due to reduced resilience.

[3] Natural species diversity, mentioned throughout this report, means the full array of native species known to Nova Scotia at the time of European settlement, and includes consideration of distribution, abundance, age-class structure, genetic diversity, and ecological inter-relationships. A goal of restoration forestry should be to steer the forest toward pre-settlement conditions, thereby creating conditions that will favour restoration of natural species diversity.

[4] Beech bark disease, caused by the introduced beech scale insect and Nectria coccinea fungus, is responsible for much of the recent decline in beech volume throughout North America (Farrar, 1995; and Ontario Ministry of Natural Resources 1998).

[5] For more detailed actual annual harvest information refer to Figure 18 in Volume 2 of the Forest Accounts.

These findings are in accord with public perceptions. A recent public opinion poll found that 91% of Nova Scotians believe the present rate of timber harvest is too high to sustain the forest for other values or uses. A majority also believes that clearcutting should not be used as a harvest method in Central Nova Scotia because it harms wildlife, ruins forests, causes erosion, looks bad, and wastes wood

However, the majority of the province's forests are privately owned, making regulation and forest protection initiatives more challenging than in jurisdictions with higher rates of public ownership of forestland. Of public land in Nova Scotia, only about 20% of provincial Crown land is classified as not available for resource extraction. Once deductions are made, about 60% of the Crown forests or 732,000 hectares are actually available for timber harvesting.[6]

Land clearing and recent increases in clearcutting and the loss of both mature forests and natural species diversity in Nova Scotia forests represent a substantial depreciation of the province's valuable natural capital assets, and a decline in forest economic value due to:

- loss of valuable species;
- loss of large diameter logs and clear lumber that fetch premium market prices;[7]
- loss of resilience and resistance to insect infestation that is enhanced by species diversity;
- loss of wildlife habitat, including decreasing populations of birds;
- loss of forest recreation values that can impact tourism;
- a decline in forested watershed protection, which has likely contributed to a 50% decline in shade-dependent brook trout;
- soil degradation and the leaching of nutrients that can affect future timber productivity;
- a substantial decline in carbon storage capacity and an increase in biomass carbon loss; and
- a decline in other essential forest ecosystem services.

This decline has been invisible in standard measures of progress based on the gross domestic product (GDP) and economic growth statistics, which give value to forests only when they are cut for timber. Because they count the extraction of natural resources as economic growth, without considering the direct and indirect costs, GDP statistics send misleading messages to policy makers and the general public and blunt potential remedial action. The GDP gives no value to standing forests, and thus counts their depletion and liquidation as economic gain. This is bad accounting, like a factory owner selling off his machinery and counting it as profit. Similarly, current timber accounting methods ignore the loss of timber and non-timber values such as natural age-class and species diversity.

By contrast, the Genuine Progress Index (GPI) assigns explicit value to natural capital assets, including the full range of forest functions and vital ecosystem services that provide multiple benefits to human society. In the GPI, natural capital is subject to depreciation when not used sustainably. Conversely, restoration forestry is seen not just as a cost, but as a re-investment in

[6] Area deductions include special use areas and leases, ecological reserves, protected beaches, offshore islands, infrastructure and abandoned railway corridors, areas of low forest capability and steep slopes, wildlife habitat, travel corridors, unique features, view planes along highways, traveled watercourses, special management zones, and riparian areas (pers. comm. D. Eidt, 2001).
[7] For this analysis, see Volume 2 of these Forest Accounts, Chapter 8.

natural capital that will produce a valuable flow of goods and services in the future. Just as a factory owner's economic viability depends on the quality and quantity of his equipment, the GPI recognizes that the capacity of forests to provide vital services to human society depends on the health of the standing natural capital stocks.

Extrapolating from one global study, Nova Scotia forests are estimated to provide a minimum of $1.68 billion (1997$) worth of services annually in climate regulation, soil formation, waste treatment, biological control, food production, recreation, and cultural benefits (Costanza et. al. 1997).[8] This estimate does not include other vital forest ecosystem services such as soil erosion control, water supply and watershed protection, nutrient cycling, gas regulation, pollination, habitat, disturbance regulation, and genetic resources. Increased clearcutting and the loss of natural forest diversity are rapidly diminishing the value of these forest ecosystem services in the province.

Nova Scotia's forests store about 107 million tonnes of carbon, thereby avoiding an estimated $2.2 billion in climate change damage costs. However, the accelerated rate of cutting, and the loss of old growth and mature forests in Nova Scotia since 1958, have drastically reduced the province's carbon storage capacity by 38%, costing an estimated $1.3 billion in lost value. In other words, based on the 1958 forest inventory, the carbon stored would be worth $3.5 billion. Carbon loss in Nova Scotia's forests is now contributing to global climate change.

Direct non-timber contributions to the Nova Scotia economy include a four-fold increase in maple sugar production over the past three decades. However, valuable forest-dependent medicinal plants that are dependent on mature forests, are becoming increasingly rare in the province as forest ecosystems with old-growth characteristics disappear.

Nova Scotians spend $250 million a year on nature and wildlife-related pursuits, a lot of it in forests, of which 70% is non-consumptive (e.g. hiking, bird-watching, canoeing) and 27% is consumptive (mostly hunting and fishing). In addition, total tourism revenues rose to a record $1.26 billion in 1999, contributed $430 million to the provincial GDP, and generated $200 million in tax revenues (current dollars), with nature tourism the fastest growing sector of the industry. The tourism industry directly employs more than 12,000 Nova Scotians, with direct and indirect tourism jobs increasing by 23.4% between 1997 and 1999. A Nova Scotia government report on the nature tourism market noted that natural settings, protected areas, parks, and opportunities for hiking and wildlife viewing were critical to the development of ecotourism market potential.

Total forest industry[9] shipments in 1999 were $1.4 billion, and contributed $431 million to GDP,[10] remarkably similar in size to the tourism industry contribution.[11]

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[8] This figure is based on global estimates of forest ecosystem values per hectare, arrived at by a team of international scientists. No such separate study has been done for Nova Scotia, and detailed scientific analysis would be required to assess the comparability of these global estimates with Nova Scotia conditions.

[9] Throughout the GPI Forest Accounts, forest industry refers to all forest sector jobs, including logging and forestry industries, paper and allied products industries, and wood industries. This is also how the term is used in the APEC (2000) report. "Forestry Industry" or "Forestry Services Industry" is used when referring to those establishments that are primarily engaged "in gathering forest products in forestry patrol, fire inspection, fire fighting in forest nurseries, reforestation and other forestry services" (Statistics Canada, l980 SIC; NAICS).

From the perspective of sustainability, however, this forest industry contribution must be assessed in relation to the health of the natural capital stocks on which it depends. Otherwise, the degradation and depletion of these stocks may appear as economic gain. For example, the fisheries industry appeared to be booming, with record catches recorded, on the eve of the Atlantic groundfish stock collapse.

When the forest industry contribution to GDP is assessed in relation to volume of biomass harvested, the trends are much more troubling. In 1984, the forest industry contributed $90,804 per 1,000 cubic metres of timber harvested. In 1999, the industry contributed only $68,023 per 1,000 cubic metres, a 25% decrease (constant 1997$). In other words, the GDP and shipment figures in isolation conceal the reality that far greater quantities of timber are being harvested to maintain a relatively fixed contribution to GDP.

Depending on which job categories are included, estimates of forest industry employment vary widely. Statistics Canada's Survey of Employment, Payroll and Hours puts forest industry employment at almost 9,000, while a recent study by APEC (2000), prepared for the Nova Scotia Forest Products Association, put the figure much higher – at 13,000.[12]

However, once again, it is not the absolute employment numbers that are most significant from the perspective of sustainability, but the employment per unit of biomass harvested. Higher ratios are a sign of genuine progress in the GPI. However, employment per unit of timber harvested has declined by 26% since the l980s, from an average of 1.9 jobs/1,000 cubic metres in the l980s to an average of 1.4 jobs/1,000 cubic metres in the l990s. In other words, greater quantities of timber are being harvested to maintain each job in the industry. [13]

Clearcutting is currently the dominant harvest method in the province, accounting for 99% of the total annual harvest. New government regulations provide financial incentives for silviculture (e.g. planting and thinning) with the goal of doubling the volume of softwood harvested from 5.5 million cubic metres (the mean harvest from 1995 to 1998) to over 11 million cubic metres by 2070.

However, the continued focus of both policy and current accounting methods on quantity rather than quality not only encourages clearcutting, but also conceals a significant loss of value per unit of biomass harvested, due to the changing age and species structure of the province's forests. The potential lost market value of premium-priced large diameter and clear lumber

[10] Shipments from APEC (2000). GDP statistics from Statistics Canada, *CANSIM II* Database, Table 379-0003, GDP at factor cost by Standard Industrial Classification (SIC).
[11] The purpose of the comparison here is not to rate one or other industry as having greater importance, but simply to demonstrate that two major Nova Scotia industries of comparable importance to the provincial economy, are both resource-dependent and share a need for sustainable management of the province's forest resources.
[12] See Volume 2, Chapter 8, for a detailed discussion of alternative estimates of forest industry employment, and possible explanations for the discrepancies.
[13] Calculations are based on the average employment figures cited by Statistics Canada's Survey of Employment, Payroll and Hours: averages of 7,401 jobs in the 1980s and 7,618 jobs in the l990s. Harvest levels used in the calculations were also based on averages of 3.8 million cubic metres in the l980s and 5.5 million cubic metres in the l990s. See also Volume 2, Chapter 9, for a discussion on the impact of mechanization in the forest industry.

through the destruction of old trees in the last 40 years alone is roughly estimated at $260 million annually, or 19% of total annual revenues.[14]

To protect and restore the value of Nova Scotia's forest wealth and the full range of forest services, this GPI study recommends:

- incentives for investment in forest restoration and uneven-aged management, including selection harvesting, in order to protect and restore the natural age distribution and species diversity of the province's forests, and to provide more jobs;
- a sharp reduction in the rate of clearcutting and the volume of timber harvested annually;
- a gradual industrial shift from volume-based to value-added forest products, to produce high-value wood products, and to increase the number of jobs per unit of resource harvested;
- protection of all remaining old-growth forest;
- that the full range of forest values and services, and the full cost and benefits of associated harvest methods, be counted and tracked in annual forest accounts and in ongoing forest management planning; and
- Sustainable forest management is not the whole answer. Even with the most careful harvesting techniques, there will be some level of impact on forest ecosystems. While there is a great difference between clearcutting and selection harvesting systems, they both involve the construction of roads and the removal of biomass. Even the highest standards applied on a particular woodlot cannot guarantee needed protection of critical forest values at the landscape level. Therefore, no matter how excellent forest operations may be, they are not a substitute for an adequate network of representative protected areas in Nova Scotia.

[14] See Volume 2, Chapter 8. This is an extrapolation derived from applying the portion of premium-priced lumber on a sustainably harvested Nova Scotia woodlot to the province as a whole. For a more accurate estimate, far more detailed analyses are necessary, based on varying forest, soil, and climatic conditions in different parts of the province, and on the different historical forest structures that existed.

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Dozens of other experts generously gave their time in interviews, and provided information to the GPI researchers. We would particularly like to thank Dr. Bill Freedman, Dalhousie University; Derek MacFarlane, Canadian Forestry Service, Natural Resources Canada, Fredericton, and Prof. Martin Willison, Dalhousie University, for their invaluable assistance. Many other experts and advisors provided material used in the accounts, and they are appropriately listed in these two volumes. We wish to thank them all for their contribution. Please excuse any inadvertent omission of contributors or reviewers not listed here.

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Inspiration for the Nova Scotia Genuine Progress Index came from the ground-breaking work of Redefining Progress, which produced the first GPI in the United States in 1995. Though **GPI***Atlantic*'s methods differ in many ways, particularly in not aggregating index components for a single bottom line, we share with the original GPI the attempt to build a more comprehensive and accurate measure of well-being than can be provided by market statistics alone. **GPI***Atlantic* also gratefully acknowledges the pioneers in the field of natural resource accounting and integrated environmental-economic accounting on whose work this study and the GPI natural resource accounts build.

Needless to say, any errors or misinterpretations, and all viewpoints expressed, are the sole responsibility of the authors and ***GPI****Atlantic.*

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FOREWORD

THE NOVA SCOTIA GENUINE PROGRESS INDEX: PURPOSES, PRINCIPLES & METHODS

Please see Appendix B for a list of the GPI components; and Appendix C for more details on the Nova Scotia Genuine Progress Index.

LIMITATIONS OF THE GDP AS A MEASURE OF PROGRESS

The most commonly used basis for assessing economic and social well-being is the Gross Domestic Product (GDP). Yet, in recent years there has been increasingly widespread acknowledgement by leading economists of the shortcomings of the GDP as a comprehensive measure of progress. Indeed, as an aggregation of the market value of all goods and services, the GDP was not intended, even by its architects, as a composite index of economic welfare and prosperity.

Using GDP levels and economic growth rates to measure progress takes no account of the value of natural, human and social capital, including environmental assets, unpaid work, and free time. It does not allow policy makers to distinguish the costs and benefits of different economic activities, and it masks changes in income distribution. Such fundamental omissions and limitations render the GDP an inadequate measure of social and economic well-being.

It should be noted that these are not flaws of the GDP per se, but of its misuse as a benchmark of economic and social health, prosperity and welfare. Nobel Prize winner, Simon Kuznets, one of the principle architects of national income accounting and the Gross National Product, never endorsed its modern use as an overall measure of progress. As early as 1934, Kuznets warned the U.S. Congress:

> *"The welfare of a nation can scarcely be inferred from a measurement of national income"* (Cobb et. al.1995).

As the GNP and its successor, the GDP, began increasingly to be used as a measure of general social well-being and progress after the Second World War, Kuznets' reservations about the limitations of the system he helped create grew stronger and he argued that the whole system of national accounting needed to be fundamentally rethought. In 1962 he wrote:

> *"Distinctions must be kept in mind between quantity and quality of growth, between its costs and return and between the short and the long run. Goals for 'more' growth should specify more growth of what and for what."*[15]

[15] Kuznets, Simon, *The New Republic,* Oct. 20, 1962, (cited in Cobb et. al.. 1995)

When the GDP is misused as a measure of well-being and progress, it frequently sends misleading and inaccurate signals to policy makers that in turn result in the depletion of vital resources, and investment in economic activities that carry hidden social and environmental costs. What we count and measure is a sign of what we value. By focusing on quantitative material growth as our primary measure of progress, we under-value the human, community and social values and environmental quality which are the true basis of long-term well-being, prosperity and wealth.

The flaws inherent in the misuse of the GDP as a measure of progress include the following:

1) The Failure to Value Natural Capital

The GDP is a current income approach that fails to value natural and human resources as capital assets subject to depletion and depreciation. As such it cannot send early warning signals to policy makers indicating the need for re-investment in natural and human capital. For example, the GDP of Newfoundland and Nova Scotia registered massive fish exports as economic growth, but the depletion of fish stocks appeared nowhere in the accounts. Similarly, the more trees we cut, and the more quickly we cut them, the faster the economy will grow.

In this report, we examine how the current failure to account for our natural environment as a valuable natural capital asset can keep the costs of unsustainable forest practices effectively off the policy agenda, and prevent determined and concerted action to protect the value of Nova Scotia's forests. Indeed, according to current accounting practices, the more forest area we clearcut and the more timber volume we send to market, the faster the economy will grow, which in turn is interpreted as a sign of well-being and prosperity. Measured from the consumption side, the more voraciously we consume timber and other resource products, the "better off" we are assumed to be.

2) The Failure to Make Qualitative Distinctions

Secondly, the GDP itself is a quantitative measure only, and fails to account for qualitative changes, both in the mix of economic activity and in the quality of our goods and services, including ecosystem services[16]. This failure can send perverse messages to policy makers, with pollution actually registering as a contribution to economic prosperity. The *Exxon Valdez*, for example, contributed far more to the Alaska GDP by spilling its oil than if it had delivered its oil safely to port, because all the clean-up costs, media activity, legal expenses, and salvage operations made a huge contribution to the state's economic growth statistics.

Thus, water pollution and bottled water sales are literally "better for the economy," according to our economic growth statistics, than free, clean water, simply because more money is spent on

[16] The Canadian System of National Accounts (CSNA) as a whole does provide information on *quantitative* shifts in the mix of economic activity by sector, industry, commodity, and province. These remarks, therefore, apply only to the use of GDP as a measure of progress, since industry and commodity shifts registered in the CSNA are rarely invoked as signals of changes in societal well-being and prosperity.

the former. Repairing the damage from extreme weather events and natural disasters due to climate change is actually counted as a contribution to our prosperity and well-being when the GDP is used to assess how "well off" we are. This happens because the GDP blindly records all money spent as a contribution to the economy, without assessing whether this spending actually signifies an improvement in well-being or a decline.

This incongruity extends even to ordinary household purchases. There is no recorded relationship, for example, between the cost of consumer durables as capital investments on the one hand and the quality of services they provide on the other, leading to the paradox that the quicker things wear out and have to be replaced, the better for the GDP.

In sum, this failure to account for qualitative changes means that increases in crime, divorce, gambling, road accidents, natural disasters, disease, obesity, mental illness, toxic pollution, and natural resource depletion all make the GDP grow, simply because they produce additional economic activity. More prisons, security guards, burglar alarms, casinos, accident costs, storms, natural disasters, dieting pills, anti-depressants, lawyers, oil spill and pollution clean-ups, and the costs of setting up new households after family break-ups, all add to the GDP and are thus conventionally counted as "progress."

This anomaly led Robert Kennedy to remark 30 years ago:

> *"Too much and too long, we have surrendered community excellence and community values in the mere accumulation of material things....The (GDP) counts air pollution and cigarette advertising and ambulances to clear our highways of carnage. Yet the gross national product does not allow for the health of our children, the quality of their education, or the joy of their play. It measures neither our wit nor our courage; neither our wisdom nor our learning; neither our compassion nor our devotion to our country. It measures everything, in short, except that which makes life worthwhile"* (Kennedy 1993).

How does the failure of our economic accounting process to make qualitative distinctions impact assessments of forest health? If loss of age and natural species diversity has increased a forest's susceptibility to spruce budworm infestation, for example, the GDP actually gains twice from the loss. First, the expenditures on spraying and combating the pest make the economy grow. Secondly, higher rates of defoliation will produce massive salvage operations, as occurred in the Cape Breton highlands in the 1980s, which are counted as contributions to economic growth and prosperity. By contrast, a multi-aged multi-species forest, harvested sustainably over time is more resilient to budworm infestation, and, with lower rates of defoliation, will actually appear comparatively disadvantaged in current year GDP statistics.

In short, because GDP statistics make no qualitative distinctions, they do not reveal whether expenditures signify an improvement in well-being or a decline. Standard economic growth measures are simply incapable of sending any signal about actual forest and natural resource health, and of distinguishing gains from losses. Indeed, resource yield statistics, though conventionally used to signal forest industry health, may well signify the precise opposite.

This flaw is replicated in the conventional resource accounting practices themselves, adopted by departments of natural resources throughout the country. Because they also use *quantitative* assessments alone to measure the "sustainability" of current harvest practices, they can be as misleading as the misuse of the GDP as a measure of progress. So long as timber "regeneration" (natural growth plus silviculture) equals or exceeds "depletions" due to harvest, fire, insects, and disease, forest practices are conventionally labelled "sustainable." This is why industries that practice extensive silviculture advertise themselves as "sustainable forest companies."

From the perspective of the Genuine Progress Index, this can be a serious misdiagnosis, because the health and depletion of our natural resources cannot be measured in quantitative terms alone. A multi-aged, multi-species old-growth forest can be replaced by a single-aged, single-species plantation, and the *qualitative* loss will never appear in the conventional resource accounts. The costs of habitat and wildlife loss, of the loss of old-growth or mature forests and natural species diversity, of soil erosion and degraded watersheds, of the loss of carbon sequestration capacity, -- these costs do not show up anywhere in our current resource and economic accounting systems, nor in the measures of well-being and progress based on them.

But the value of natural capital, just like the value of the manufactured capital that *is* counted in the conventional market statistics, clearly depends on its quality as well as its quantity, and the costs of its depreciation must be assessed on both quantitative *and* qualitative grounds. As the World Commission on Forests and Sustainable Development recognized (see frontispiece above), we currently have no adequate measure of forest health, and we urgently need "a measure for the changing value of the forest capital of the world." Without such a measure, forest decline will remain absent from the policy arena, and incentives for potential restorative action will never make it onto the policy agenda.

BETTER WAYS TO MEASURE PROGRESS

By accounting for a more complete range of forest values, including qualitative non-timber ecological values, this set of forest accounts is intended to help remedy that serious flaw and to contribute to the World Commission's objective of creating a genuine measure of forest health. The Nova Scotia GPI[17] is by no means the first attempt to do so, but simply applies in a practical, policy-relevant way, the ongoing work in this area by the World Resources Institute and other pioneers in natural resource accounting, and the criteria and indicators already adopted by the Canadian Council of Forest Ministers and the Montreal Process.[18]

By contrast to measures of progress based on the GDP, the Genuine Progress Index accounts for the value of our natural resources by treating them as capital assets, subject to depreciation, and requiring re-investment if they are depleted or degraded. With the caveat that natural capital is

[17] See Appendix B for a list of the GPI components, and Appendix C for more details on the Nova Scotia GPI.
[18] See Chapter 1 below. The "Montreal Process" refers to the criteria and indicators endorsed in February, 1995, by 10 countries, representing 90% of the world's temperate and boreal forests, as members of the international Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests.

not *inherently* subject to depreciation if used sustainably, the GPI therefore treats these assets just as conventional accounting systems treat manufactured capital.

Like other forms of capital, forests provide services by performing a wide range of ecological, social, and economic functions. They protect watersheds, prevent soil erosion, provide habitat for wildlife, regulate the climate, sequester carbon from the atmosphere, and provide timber, jobs and recreation to human society. The GPI therefore defines "sustainable" resource use as the capacity to enjoy these services, and to live off the "interest" provided by these assets, without depleting the capital stocks.

Our forests are defined as healthy, if they are able to perform their manifold functions effectively and optimally. Any improvement in their capacity to perform these functions and provide these services is a measure of "genuine progress" in the GPI. Conversely, any diminution in this capacity, whether through a depletion of capital stocks or through a degradation of the quality of standing stocks is treated as depreciation. Just as factory equipment may need to be replaced or repaired in order to maintain a flow of goods and services, so a degraded forest may require re-investment in the form of restorative forestry.

Unlike the GDP, therefore, which counts only the timber removed from the forest, the GPI also values what remains in the forest. The standing stocks, after all, will determine the capacity of the forest to continue providing not only timber but a wide range of other vital services to human society and to other species.

While the preceding paragraphs sketch the GPI approach to natural resource accounting, components of the GPI attempt to remedy other flaws in our current measures of progress, by:

- accounting for unpaid work and free time as well as paid work (and thus accounting fully for *time*);
- assessing not only the total quantity of income, as the GDP does, but also how that income is shared and distributed;
- making qualitative distinctions between economic activities that enhance well-being and those that signify a decline in the quality of life. In the GPI, for example, crime, sickness, pollution, and greenhouse gas emissions are counted as costs rather than gains to the economy. In assessing genuine progress, therefore, *less* is sometimes better in the GPI, unlike measures based on the GDP which assume that more is always better, regardless of *what* is growing.

In these ways, the Genuine Progress Index can provide a more accurate and comprehensive measure of well-being than conventional measures based on economic growth statistics alone. The health of our natural resources, including the health of our forests, is a key component of societal well-being in the Genuine Progress Index. That is the context for these GPI forest accounts. They are designed as practical policy tools, to be used by policy makers and the general public on a regular basis to assess whether we are making genuine progress as a society.

PART I

INTRODUCTION, FRAMEWORK & SOURCES

1. The Importance of Forest Accounts

"The UN System of National Accounts, the world's yardstick for measuring economic performance, is a flawed framework for appraising the sustainability of economic growth. While it measures how such man-made assets as factories and equipment depreciate as they are used in current production, it leaves out the effects of resource depletion and degradation. For example, national income accounts record timber output, fish harvest, and crop production as income but ignore the costs of deforestation, overfishing, and soil erosion.

"A nation's depletion of its natural resources - consumption of natural capital - can therefore masquerade as growth for decades, even though it will clearly reduce income prospects from resource sectors in the future. Just as ignoring the deterioration of man-made assets skews economic assessments, so does overlooking the degradation of natural assets"

James Gustave Speth, President, World Resources Institute (World Resources Institute 1991)[19]

"The national accounts fail to accurately describe changes in the quality and quantity of natural capital stocks, in contrast to the way stocks of manufactured capital are treated. Factories and machinery are counted as productive capital, and when they wear out or suffer accidental damage, it is labelled capital consumption and the value of the loss is subtracted from the GNP. Not so for natural capital; the wear and tear on forests, soil, air and water caused by their exploitation is not subtracted from their value.

"Further, the accounts that summarize input and output do not explicitly show the value of the services provided by ecosystems in absorbing and "processing" wastes, nor the value of defensive expenditures against pollution, such as pollution abatements, and so on, which are categorized with other investment items.

"The accounts also do not reflect the income value of non-market services such as recreation on public lands, aesthetic benefits, the potential benefits of biological diversity, or so-called non-use benefits, which are those derived from simply knowing (for example) that an endangered species is surviving even if one never sees it, or that wilderness areas still exist even if one never visits them."

Thomas Prugh, International Society for Ecological Economics (Prugh et al. 1995)

[19] It should be noted that these insights preceded the 1993 revisions to the UN System of National Accounts which acknowledged the earlier omission of natural resource values and recommended for the first time that natural resource accounts be incorporated into national balance sheets, and that "a satellite system for integrated environmental and economic accounting" be adopted (United Nations 1993). Despite these recommendations, conventional national income accounts and economic growth statistics still dominate the accounting and reporting mechanisms of UN member nations that adhere to the UN System of National Accounts. Indeed, satellite accounting procedures may actually serve to exclude environmental considerations from the mainframe accounts that set the policy agenda, and James Speth's critique remains true today in actual practice.

These critiques help explain the under-valuation of the world's forests and the benefits they provide. Currently, forests are only valued in the standard national and provincial economic accounts and in the Gross Domestic Product (GDP) for their timber values. In other words, forests are not given economic value until they are cut for timber, and they are, therefore, undervalued by definition, because the standard measures exclude a wide range of standing forest values (McNeely 1988). Economic theory has generally viewed the natural environment as a resource to meet the needs of the market economy, with no explicit valuation in the accounting system of essential life support services, such as purification of air and water that are provided "free of charge" (de Groot 1992, Lutz 1993).

The integration into the current market economy of both the benefits provided by natural goods and services, and the costs due to losses in environmental quality resulting from unsustainable resource management, is necessary for the solution of pressing environmental problems (de Groot 1994). The United Nations itself has identified the need for integrating environmental assets into national accounting mechanisms (Abaza et al. 1999)

Current pricing and production systems are based on incomplete cost-benefit analyses and economic accounting procedures that value man-made assets, but do not value natural ecosystem capital and environmental functions. The systematic inclusion of environmental functions provided by natural ecosystem capital will enable decision-makers to determine whether social and economic development activities (the product of man-made economic capital) enhance or degrade the value of natural capital. To view natural ecosystems as a cheap source of resources to be used for short-term economic gain will eventually undermine economic strength, as we learned from the collapse of the Atlantic ground-fishery. Rather, natural resources should be seen as productive natural capital that can provide goods and services in perpetuity if conserved and used sustainably.

The GDP is widely used by governments, economists and the media for a purpose its founders never intended - to measure the economic progress, prosperity and well-being of a nation or region. The GDP only measures the market value of goods and services exchanged for money. The GDP and the System of National Accounts do acknowledge that produced capital such as machinery depreciates, but these accounting systems do not extend that reasoning to natural capital (Anielski 1992, MacGregor and MacFarlane 1997).

Therefore, the more trees we cut, the more fish we sell, and the more fossil fuels we burn, the more the GDP grows. This accounting will eventually result in a loss of benefits and services. The absence of natural capital from our economic measures means we are not keeping good accounts of our most important assets, on which the health of the human economy ultimately depends.

Counting the depletion of natural capital as gain in the national accounts sends a misleading message to policy-makers (National Resource Council 1994, Prugh 1995, Repetto et al.1989, Serageldin and Steer 1993, World Resources Institute 1991). This is sending policy-makers inaccurate information that impedes the implementation of sustainable forest practices (MacGregor and MacFarlane 1997, Abaza et al. 1999). In the case of natural resource depletion, GDP growth may actually signify a decline in well-being rather than a gain in prosperity, as is commonly assumed.

> *"National income accounts, the information framework that countries use to analyze the performance of their economies and to determine gross and net national product [or GDP], ought to encompass the concept of sustainability. And, indeed they do in certain respects. Man-made assets, including plant and equipment, are valued as productive capital, and their depreciation is charged against the value of national production. But this treatment of capital depreciation ... does not extend to natural resource depletion.*
>
> *"The result is what Robert Repetto and his co-authors refer to ... as a 'dangerous asymmetry'. As he notes: 'A country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife and fisheries to extinction, but measured income would not be affected as these assets disappeared'. When the index by which we try to measure improvements in living standards ignores the loss of natural resources and the services they provide, policymakers can get very misleading signals."*

James Gustave Speth, President, World Resources Institute (Repetto et al. 1989)

Changes in societal values and a greater recognition of our reliance on the ecological services of forests have prompted the development of new approaches to resource accounts. In order to move towards sustainable use and conservation of forests, policy makers, interest groups and the public need accurate information on the ecological, social, and financial values of forests (Gregerson et. al. 1995).

International organizations such as the World Bank, the United Nations, the World Commission on Forests and Sustainable Development, the World Resources Institute, The Centre for Social and Economic Research on the Global Environment, and the Canadian Council of Forest Ministers, have all begun to develop indicators and measures of natural capital in order to assess the full ecological services and benefits of forests.

In addition, non-market valuations of natural capital are becoming increasingly important in demonstrating that ecosystem services, traditionally regarded as free, in fact have great economic value. For example, an international group of scientists recently used replacement values and contingent valuation methods to estimate the value of the world's ecosystem services at US$33 trillion per year (Costanza et. al. 1997).[20]

Forest timber products are in high demand world-wide, and there is therefore an increasingly pressing need for criteria and indicators that include ecological, social and financial values to

[20] Replacement values seek to assess what it would cost to replace nature's free services with human engineering or other works. Contingent valuation methods are used to assess people's "willingness to pay" for these services. The latter are controversial, because of the difficulty of scaling responses, the difference between intentions and actions, and the frequently subjective nature of the survey instruments. (P. Woolaver, NSDNR 2001, points to some of these difficulties.) In their defence, some ecological economists argue that it is still far more accurate to recognize the non-market value of nature's services than to assign them an arbitrary value of zero, as conventional accounting mechanisms imply.

ensure ecologically sustainable forest management, conservation of forest biological diversity,[21] social stability, and resilience. Without such measures, the growing demand for timber may soon outstrip the world's timber supply.

The World Commission on Forests and Sustainable Development advocates a Forest Capital Index as an international tool to assess changes in forest capital both qualitatively and quantitatively, to value forest ecosystem services, and to create market mechanisms to compensate countries for ecological services (Krishnaswamy and Hanson 1999). The World Commission report asserts that using criteria and indicators to assess these qualitative and quantitative changes over time is a more thorough approach than monitoring rates of deforestation and reforestation.

For the purposes of this study, the Genuine Progress Index (GPI) has adopted the criteria and indicators of the Canadian Council of Forest Ministers and the Montreal Process[22] in explicitly addressing the following forest values:

- biological diversity and genetic resources,
- carbon storage and sequestration for mitigation of global climate change,
- soil erosion control and sediment retention,
- water supply and regulation,
- nutrient cycling, biological control, and other ecosystem services, and
- provision of timber, employment, recreation, the protection of natural and cultural heritage, and other social, economic and cultural benefits.

Future work will focus on the use of market and non-market valuation methods to assign economic value to the full range of forest benefits and services, and to measure the economic benefits of forest ecosystem services, and the full costs associated with human use. The physical data in these forest accounts will provide the basis for a more systematic economic valuation than has been possible at this early stage of development.

In sum, what we count in our core measures of well-being and progress literally reflects what we value as a society. Likewise, our definition of "wealth" literally shapes the world we leave our children. If we count only material goods and ignore the value of our natural assets, we virtually

[21] Biological diversity, or 'biodiversity', describes the variety of life forms, the ecological roles they perform and the genetic diversity they contain (Wilson and Peter 1988, p.71). Some definitions of biodiversity also include ecological functions and services (i.e. what organisms and ecosystems do for each other, their immediate surroundings and for the ecosystem as a whole), ecosystem diversity (i.e. the number of different ecosystems and their relative frequencies over the landscape), as well as the abiotic matrix, which includes the unity of soil, water, and air within which the above exists (FSC 2000).

[22] The Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests ("Montreal Process") was formed in Geneva in June 1994 to advance the development of internationally agreed criteria and indicators for the conservation and sustainable management of temperate and boreal forests at the national level. Participants in the Working Group include Australia, Canada, Chile, China, Japan, the Republic of Korea, Mexico, New Zealand, the Russian Federation, and the United States of America, which together represent 90 percent of the world's temperate and boreal forests. Several international organizations, non-governmental organizations, and other countries also participated in meetings of the Working Group. In February 1995 in Santiago, Chile, the above countries endorsed a comprehensive set of criteria and indicators for forest conservation and sustainable management, for use by their respective policy-makers.

guarantee that future generations will inherit a poorer rather than a richer natural world. By contrast, if we measure the value of the forests that we leave behind compared to their value when we inherited them, we will act responsibly for the sake of our legacy to future generations. That is the fundamental purpose of this study.

2. Forest Account Framework

Most timber accounts in Canada currently monitor depletions and regeneration, assigning minimal importance to forest quality. In general, timber accounts have not included non-timber forest values, nor forest ecosystem goods and services. For example, Statistics Canada has introduced Timber Asset Accounts, as part of its Natural Resource Stock Accounts which in turn form part of the new Canadian System of Environmental and Resource Accounts (Statistics Canada 1997, *Econnections*[23]).

Statistics Canada's Timber Asset Accounts contain two accounts: the physical timber asset account and the monetary timber asset account. These accounts provide a good assessment of Canada's forests for timber supply, but they have not yet integrated forest ecosystem management and non-market benefits. Indeed, Statistics Canada suggests that, "future editions of the Timber Asset Accounts could cover economic uses of the forest beyond timber supply and uses or benefits that are outside the domain of market-based activities" (Statistics Canada 1997). This GPI study is a contribution to that effort.

To work towards ecologically sustainable forests and communities, a more comprehensive range of forest values needs to be identified, valued, and monitored. Indeed, the extraction of timber may not be the most economic use of our forests where such disturbance negatively affects other forest goods and services. For example, a recent study in the United States found that national forests are worth more standing than cut for timber. This study reports that National Forests:

- supply clean water worth $3.7 billion per year,
- sequester carbon worth nearly $3.4 billion per year,
- provide recreation value contributing 2.9 million jobs and $111 billion per year to the GDP, and
- provide habitat for tens of thousands of wild pollinators with a potential worth of $4.7 billion per year to the agriculture sector (Talberth and Moskowitz 1999).

By contrast, the Forest Service estimates that U.S. National Forests generated net economic benefits from timber production of $345 million and 55,535 jobs in 1997 (Talberth and Moskowitz 1999).[24]

[23] Statistics Canada, Econnections: Linking the Environment and the Economy: Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts, catalogue no. 16-505-GPE, December, 1997.
[24] The purpose of this illustration is not to suggest that a choice must be made between timber and non-timber values. On the contrary, as Peter Woolaver, NSDNR, correctly points out (2001), "with proper management it should be possible to have more of both in total." The illustration of the value of standing forests is necessary, however, in light of the historical evidence in Nova Scotia, that has seen most of the province's forests managed exclusively for timber production and, as the evidence in this report demonstrates, to the detriment of other forest values. It is precisely in order to demonstrate the "proper management" that will make it "possible to have more of

GPI Atlantic recommends that the physical data in these Forest Accounts be used as the basis for similar future economic valuations of the full range of forest services. Such economic valuations are essential to create the financial incentives necessary to promote sustainable forest management. The Talberth and Moskowitz (1999) valuation methodology, along with the methods of Costanza et. al. (1997) and others, might be applied to Nova Scotia's forests to assess a range of economic values for the province's forest services. Compiling these physical data is a first step in that direction.

Presently, timber extraction is accepted as the dominant economic activity in forests. However, the effects of forest management on forest, water and environmental quality, and the effect on other human activities and needs, should be more systematically evaluated. Fortunately, the Canadian Council of Forest Ministers (CCFM) has now developed an excellent and comprehensive suite of criteria and indicators for the conservation and sustainable development of Canada's forests (CCFM 1995). However, these indicators have so far had a limited impact on forest policy, partly because they have not yet been integrated into the financial system that provides the economic incentives and mechanisms that regulate behaviour and policy. This implementation gap is a consequence of the lack of proper signals in the market that would enable the forest industry and woodlot owners to move towards more sustainable practices.

In 1995, the CCFM identified six basic criteria:

- Conservation of biological diversity;
- Maintenance and enhancement of forest ecosystem condition and productivity;
- Conservation of soil and water resources;
- Forest ecosystem contributions to global ecological cycles;
- Multiple benefits of forests to society; and
- Accepting society's responsibility for sustainable development.

The Coalition of Nova Scotia Forest Interests' forest strategy for the province states that there are growing concerns for non-timber values, including the quality, health, and character of our forests (The Coalition of Nova Scotia Forest Interests 1996). Nova Scotia's forest policy[25] includes several objectives relevant to the GPI approach:

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both in total" that the second volume of these accounts is dedicated to presenting outstanding examples of timber production and forest management that are entirely compatible with the maintenance of a full range of other forest values. Indeed, the often expressed conflicts between the tourism and forestry industries which have characterized this province and to which Mr. Woolaver eloquently attests, are shown to be effectively reconciled in examples like that of Algonquin Park, Ontario (Volume 2, Chapter 4.) Due to lack of time and financial resources, these GPI forest accounts have not been able to undertake an in-depth analysis of Nova Scotia's Integrated Resource Management planning process for Crown lands, the intent of which is to reconcile different forest uses and values. The considerable controversy surrounding that plan, briefly alluded to in Volume 2 of this report, indicates that the IRM process is not seen by many groups as attaining that objective. Nevertheless, these GPI accounts share Mr. Woolaver's aspiration to see a transition to proper management of operable forestlands that enhances the full range of forest values and uses, including appropriate timber production.

[25] Peter MacQuarrie (NSDNR. pers. comm. 2001) notes that these forest policy objectives should probably be attributed to the 1985 Forest Policy or the Forests Act of 1986.

- To achieve a healthier, more productive forest, capable of yielding increased volumes of high quality products;
- To support private landowners to make the most productive use of their forest lands;
- To achieve more effective management of all Crown lands;
- To maintain or enhance fish and wildlife habitats, water quality, recreational opportunities, and associated resources of the forests;
- To enhance the viability of our forest-based manufacturing industries

The 1994 Nova Scotia Forest Accord, signed by the federal and provincial governments and representatives of all sectors of the forest industry, pledged to:

- *"fulfil our national responsibilities in the care and use of forests, maintaining their importance to the environment and the well-being of all living things, (and)…*
- *"expand our capacity to provide the public with timely, accurate, and balanced information on the state of forests and forestry issues in Nova Scotia and provide opportunities for the Nova Scotian public to have a greater say in how public forests are used and managed."*

Nova Scotia Forest Accord, 22 December, 1994, Halifax

These forest accounts are intended as a contribution to that effort. *How* then do we value our forests fully in order to keep track of changes over time, and to ascertain whether forest values are increasing or declining? Some non-timber products, like mushrooms and other food sources, can be quantified in monetary terms because they are of direct economic importance. However, assessing the dollar value of most ecosystem values is complicated and controversial. De Groot (1992, 1994) suggests the use of different socioeconomic values for each function (Table 1): conservation value, existence value, health option value, consumptive use value, productive use value, and employment.

In the following pages, some of the above indicators of forest health, quality and values are measured using the limited available data. The framework for criteria and indicators is derived from the CCFM and the Montreal Process' Criteria and Indicators for Boreal and Temperate Forests,[26] which are here examined for the province of Nova Scotia. The changes over time in the province's forest ecosystems, and the ability of the province's forests to maintain their provision of ecological services and benefits are considered.

Future work will include the economic evaluation of forest ecosystem services as flows providing benefits to society, as well as the full costs of forest ecosystem decline. The results presented in this report have been limited by the funding, information and data available at this time. Because qualitative indicators have only been acknowledged more recently, there is still a lack of comprehensive data in many important areas. As the new CCFM framework of criteria and indicators begins to affect policy and as it is implemented at the operational level, assessment will become more feasible.

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[26] The Montréal Process is the Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. It was formed in Geneva, Switzerland, in June 1994 to develop and implement internationally agreed criteria and indicators for the conservation and sustainable management of temperate and boreal forests.

Table 1. Ecosystem Functions for Forest Valuation

Regulation Functions	Indicators
Regulation of the local and global climate	- carbon sequestration, temperature,
Regulation of runoff and flood-prevention	- hydrological cycle
Water catchment and groundwater recharge	- biomass rainfall interception
Prevention of soil erosion and sediment control	- tree height structure and density, root systems, leaf area, soil porosity and organic matter, interception
	- soil interception, tree structure, sedimentation
	- organic cycling, litter decomposition
Formation of topsoil and maintenance of soil-fertility	- photosynthesis, plant biomass
Fixation of solar energy and biomass production	
Storage and recycling of organic matter	
Storage and recycling of nutrients	- ecologically balanced ecosystem populations
Regulation of biological control mechanisms	- habitat, streams, wetlands
Maintenance of migration and nursery habitats	- habitat, wildlife, plants, fungi,
Maintenance of biological and genetic diversity	microorganisms
Carrier Functions	**Indicators**
Wildlife habitat	- structural diversity, age diversity, food sources, nests and dens
Recreation and tourism	- attractiveness, uniqueness, natural diversity, 'naturalness' (nature study, sports, relaxation)
Nature protection	- reserves, parks
Production Functions	**Indicators**
Oxygen	- photosynthesis, respiration, decomposition
Water (drinking, irrigation, industry etc.)	- water quality, runoff
Food resources	- berries, mushrooms, nuts
Genetic resources	- ecosystem & species diversity, population viability
Medicinal resources	- medicinal plants and fungi, biochemical properties
Raw materials for building, construction, industry	- timber, pulpwood
Fuel and energy	- fuelwood
Information Functions	**Indicators**
Aesthetic information	- aesthetic quality, landscape, vegetation cover
Spiritual and religious information	- spiritual enrichment, continuity, religion
Cultural and artistic inspiration	- heritage values, archaeological sites, old-growth
Scientific and educational information	- understanding and knowledge of functions of natural systems, nature study, environmental education, applied scientific research, new medicine discoveries, natural process monitoring

Source: de Groot 1992, 1994.

A fundamental principle of GPI full-cost accounting methods is to recognize that non-market economic valuations are secondary or derivative processes, that require a firm foundation in physical evidence. After two years of investigation, the GPI Atlantic researchers concluded that the basic physical data for a full-fledged economic valuation of Nova Scotia's forest services were not yet available. For that reason, this first iteration of the Nova Scotia forest accounts focuses on assembling baseline physical data that can provide a basis for a more complete economic valuation at a later stage. Nevertheless, this study points towards pieces of the economic valuation puzzle wherever possible.

While basic physical data are lacking for many indicators of forest quality and health, attempts at economic valuation are also very difficult. Nevertheless, non-timber forest functions clearly do have economic value. For example:

- Species and genetic diversity can increase forest resilience and provide protection against spruce budworm and other infestations, producing direct economic savings as a result of lower rates of defoliation and loss.
- Mixed age forests ensure a higher proportion of wide-diameter and clear lumber that can fetch higher market prices than lumber from younger managed single-age forests.[27]
- Overall forest biodiversity and habitat protection enhance forest recreational values and tourism opportunities, providing economic benefits.
- Protection of good soil quality ensures future timber productivity.
- Forested watersheds protect against excess runoff and sedimentation, providing protection for fisheries.
- Forested watersheds also protect the quality of drinking water, and save expensive filtration costs.[28]

In short, non-timber values clearly include benefits not only for the environment, but for the human economy. Despite the acknowledged lack of precision that accompanies such economic valuations, this study attempts to recognize economic values wherever possible, because even imprecise valuations of non-timber forest values are more accurate than assigning them an arbitrary value of zero, as is the case in our current accounting mechanisms.

Money will always be an extremely limited and imperfect tool for such non-market valuations, as explained in Appendix C. Nevertheless GPI Atlantic recognizes that monetary valuations are necessary at the present time in order to bring the full range of forest values into the policy arena and to ensure their maintenance and protection. Preliminary economic estimates of forest values have therefore been made wherever possible, while acknowledging that these do not yet constitute a comprehensive valuation of all Nova Scotia forest values. As noted above, the most important prerequisite for such a comprehensive valuation is an improvement in the physical accounts and the databases for the physical monitoring of forest health.

[27] See Volume 2, Chapter 8, for this analysis

[28] See Wilson, Sara J., *The GPI Water Quality Accounts,* GPI Atlantic, Halifax, NS, July, 2000, Section 9.2, pages 115-117. This provides a concrete example of net savings to New York City estimated at $9 billion over 10 years as the result of forested watershed restoration in the Catskill Mountains.

Because GPI Atlantic is concerned to present the entire framework for sustainable forest management agreed to by the CCFM and the Montreal Process, even those indicators for which data are not currently available are listed as sub-heads in this study. Presenting results based on available data within this more comprehensive framework serves the important purpose of identifying current data gaps, and encouraging more complete future updates of this report using new data sources and improved valuation methods that will gradually become available over time.

3. Forest Ecosystem Services

Forest ecosystem services can be defined as the services provided by ecosystems through their natural functions, such as nutrient and water cycling. Because all life is dependent on the ecological goods and services provided by the earth's natural systems, their total value is infinite (Costanza et. al. 1997). Because of this vital role in supporting life on earth, it is essential to monitor changes in ecosystem health over time and to determine the effects of human activities on the environment. Ultimately, losses in ecosystem goods and services produce major costs to human economies in the form of restoration, substitution, clean-up, scarcity, and impacts on human health and well-being.

The “direct –use” values of forests include timber, non-timber forest products, medicinal plants, plant genetic resources, fishing, recreation and tourism, and education. Indirect values include soil conservation, nutrient cycling, watershed protection, flood control, microclimate regulation, and carbon sequestration. Theoretically at least, these values can be aggregated to provide an estimate of the total economic value of forests. A wide range of criteria and indicators clearly need to be included in both our national forest accounts and in forest management planning. Table 2 is a summary of one analyst's assessment of some of the different types of forest values.

Table 2. Forest Use and Non-Use Values, and Types of Benefits

Total Economic Value				
Direct Use Values	Indirect use values	Option values	Existence values	Bequest values
Type of benefit **Timber** **Recreation** **Biodiversity** **Economic Security** **Landscape**	**Biodiversity** **Watershed/ Ecosystem Function** **Microclimate** **Greenhouse Impact** **Community Integrity** **Air Pollution** **Water Pollution**	**Biodiversity** **Recreation** **Community Integrity** **Landscape**	**Biodiversity** **Landscape**	**Biodiversity**

Though monetary valuations of these values are fraught with difficulty, ecological economists have attempted to make such estimates in order to demonstrate and make visible the enormous value provided by forest ecosystem services, a value that is generally hidden in standard accounting practices. Their estimates differ widely. For example, estimates of the economic value of forests in Central America range from $US80 per hectare per year to $500 per hectare per year (Table 3).

Table 3. Total Economic Value of Forests in Central America (various estimates)

Country	Value
Mexico	US$4 billion/year; US$80/hectare/year - ecological values only
Panama	US$500/hectare/year - total economic value including use and non-use values
Costa Rica	US$133-$278 million/year; US$102-$214/hectare/year (discount rate of 8%) - total economic value

Source: Myers 1997, Adger et al. 1995.

It should be stressed again that this type of evaluation does not suggest that the importance of nature can or should only be reduced to a dollar value (de Groot 1992,1994). Ecosystems and ecological services can be described and physically evaluated, a procedure that is far more precise and informative than monetary valuations.

Monetary valuations are simply a strategy that is temporarily necessary to bring non-timber forest values into a policy process that is currently dominated by budgetary and market considerations. In the long-term, it is clearly more desirable for policy-makers to consider environmental, social and economic indicators, each in their own right, in all major decisions. Monetary valuations should always, therefore, be seen as a strategic addition to, not a replacement of, intrinsic and intangible forest values that are best expressed in physical terms. Therefore, in this report, we consider physical indicators of forest ecosystems first and foremost, and then estimate just a few of the economic benefits and costs that can more easily be calculated at this time, recognizing that this falls far short of the total economic assessments attempted in Table 3.

4. Global & Canadian Forest Trends

> *"Ironically, while many people in northern countries look at tropical forests with concern, they may be unaware that the temperate forests in their own backyards are the most fragmented and disturbed of all forest types"* (Abramovitz 1998).

4.1 The State of the World's Forests

> *"The economic benefits of forest exploitation or conversion are routinely overestimated, in large part because the ecological and economic costs of the exploitation are ignored …. While governments consistently overestimate the benefits of the extractive timber industry... they underprice timber and other forest resources"* (Abramovitz 1998).

A recent study by the Worldwatch Institute reports dramatic declines in forest quality due to logging and atmospheric pollution in North America, Europe and Asia (Abramovitz 1998). The Worldwatch report notes that as forest quality decreases, forests become more susceptible to pests, disease, and nutrient and water deficiencies associated with timber harvesting. Therefore, losses in forest quality due to declines in genetic, structural, and natural species diversity have direct implications for the well-being and resilience of forests. If forests become increasingly susceptible to disease, pests, and deficiencies, they will also decline in timber value, resulting in economic losses. In short, the Worldwatch report clearly demonstrates that a forest's timber values can be protected and enhanced by protecting the environmental and non-timber values of forests, and that those direct timber values decline when ecological values are neglected.

The Worldwatch report (Abramovitz 1998) identifies several factors that have affected the quality of the world's forest ecosystems:

1) Firstly, many secondary forests and plantations that have established on cut-overs and abandoned agricultural fields have a more uniform age structure, with lower biological and structural diversity, than natural forests.
2) Secondly, up to 20 kilometres of logging roads are built for each square kilometre of forest management area. Roads directly weaken forest water retention and soil fertility.
3) Thirdly, the non-timber benefits and services provided by large intact forests are undervalued, resulting in erroneous accounts of forest capital and ecological services.
4) Fourthly, forests continue to be sold at stumpage rates below even that of the timber value. For example, a World Resources Institute report (see below) remarks that Canada's stumpage rates are half their equivalents in the United States.
5) Lastly, global trends demonstrate that individuals and governments continue to cash in their forests, especially during difficult times, for revenues or short-term job creation, but at the expense of the natural assets.

4.2 The State of Canada's Forests

Most recently, the World Resources Institute and Global Forest Watch Canada published a report entitled *Canada's Forests at a Crossroads: An Assessment in the Year 2000* (Global Forest Watch Canada 2000). The report contains a number of physical and socio-economic indicators of the state of Canada's forests at both the national and provincial levels. Valuation criteria include: forest cover indicators, forest condition, logging trends, natural disturbance trends, sustainability, and socio-economic value of the forest industry. Results and trends for Canada include the following:

- The Maritime provinces have the highest proportion of logged forests in Canada.
- Canada's forests are managed predominantly for timber. However, polling data indicate that Canadians most value forests for non-timber uses.
- Although Canada is promoting sustainable forest management policies, implementation remains a problem, and widespread cuts in government budgets and staffing have resulted in a shift of responsibilities (e.g. forest planning, management, and enforcement) to industry.
- A lack of publicly available forest information hinders accountability and informed decision-making.

Forest industry consolidation has resulted in the concentration of large areas being controlled by a few companies. Thirteen companies now hold 48% of Canada's forest tenure area.[29] Each of the 13 have tenure to an area equal to or greater than the size of Switzerland.

4.3 Reports on the Forest Industry

The Atlantic Provinces Economic Council (APEC) recently published a report, funded by the Nova Scotia Forest Products Association, on *The Economic Impact of the Forest Industry on the Nova Scotia Economy*. The report estimated that the forest industry contributes $450 million to the provincial economy, about 2.4% of GDP - virtually constant over the last decade. APEC also reported that primary forest and related manufacturing directly employed 13,000 people in 1998, according to the North American Industrial Classification System.

A similar report, entitled *The Forest Industry in British Columbia*, is prepared each year by Price Waterhouse (Gale et. al.1999). These reports provide good summaries of the economic benefits of the timber industry but have two significant limitations. They outline the economic benefits of the timber industry, but do not consider *either* the full economic costs of timber harvesting, *or* the non-timber values of forests for provincial economies. A critique of the 1997 PriceWaterhouse report concludes that benefits generated by the forest industry are overestimated because there is no accounting either for the social and environmental costs of logging, lumber, and pulp and paper production, nor for foregone economic activities, like recreation (Gale et al. 1999). This critique recommends a sustainability accounting approach that includes the full costs and benefits of industrial forest use.

Additional indirect or ripple effects of the forest industry on the economy are estimated using input/output models. However, recent studies have found that unidirectional models such as input/output analysis are not appropriate for sectors such as forestry. According to one critique, the input/output model assumes that prices of inputs and outputs are fixed, and that there are no constraints on the supply (Alavalapati et. al. 2000). In short, forest industry reports consistently indicate economic benefits, while reports on forest quality point to serious sustainability problems.

[29] Tenures or license agreements give rights to companies to log forests.

5. Nova Scotia's Forests

> *"Evidence indicates that the quality of the forest in Nova Scotia, which occupies 84% of the Province's land area, has deteriorated substantially during 350 years of harvesting. Both hardwood and softwood trees have decreased in height and girth since the 19th century. Species composition has been changed as lumber was 'high-graded' from the forests and as more valuable species for fiber were removed by the pulp and paper industry. The proportions of sugar maple, yellow birch and white ash in the forest decreased even during as short a period as 1958-1971. White pine as a major species was replaced by red spruce and this species by balsam fir"* (Wilson et. al. 1980).

5.1 History of Timber Use

Nova Scotia has experienced a relatively long history of timber clearing. The French were the first to clear large areas for agricultural use in the 1600s and 1700s. In the 1800s, white pine was high-graded for masts and squared timber, and shipped from Nova Scotia to Great Britain during the Napoleonic Wars. In the 1890s, pulpwood was first exported from Nova Scotia (Johnson 1986).

The first provincial forest survey was undertaken in 1912 by Dr. B.E. Fernow, who found that the province's forests had been depleted. Fernow recommended improved logging techniques and restoration efforts to ensure a healthy, high quality, and high volume forest supply for saw-log production in the future (Fernow 1912).

The second forest survey was conducted in 1958 by the Department of Lands and Forests. This report stated the province had lost the majority of its primary forest, increased the land area covered with non-commercial or low-value species, and suffered greater insect damages due to reduced resilience (Hawboldt and Bulmer 1958). At the time, the pulp and paper industry was expanding. Despite the findings and recommendations in these official forest surveys, however, shortened rotation periods and clearcutting became the predominant methods in forest management in Nova Scotia.[30]

A series of Environment Canada publications has examined the effect of forestry practices on environmental quality in the Atlantic provinces (Wilson et. al.1980, Eaton et. al. 1986, Environment Canada 1994). In 1979, Wilson et. al. (1980) reported that the management of forests continued to focus on the needs of the forest industry and "the value of forest ecosystems as a habitat for wildlife and fish and as recreational and aesthetic amenities has been maintained only by chance, rather than as a conscious management effort". The authors also observed that

[30] NSDNR today maintains the position that "clearcutting is a legitimate harvest technique along with selection harvest, shelterwood harvests, etc." and that "the choice of harvest lies clearly with the land owner or manager" (Fage 2000).

the principal problem in Nova Scotia and New Brunswick was a shortage in supply, and therefore, warned that annual over-harvesting would result.

In 1994, Environment Canada (1994) reported that the annual regional forest harvest had reached record levels, with the volume of wood harvested increasing by 60% from the early 1960s to the late 1980s. Despite the clear warnings they contained, none of these earlier reports anticipated the massive increase in clearcutting that occurred in the 1990s. As the evidence in this study indicates, average harvest volumes in the 1970s and 1980s actually appear relatively steady by comparison with 1990s levels.

In 1997 the National Round Table on the Environment and the Economy reported significant over-harvesting on Maritime woodlots, and noted that poor record-keeping and reporting requirements had resulted in a lack of reliable data and an absence of standards and controls. The report noted that the existing structure of financial incentives and penalties actually encouraged unsustainable harvesting practices, and it contained warnings that the forest industry in the Maritimes might be on the verge of a collapse analogous to that in the ground-fishery (NRTEE 1997). New forest regulations introduced recently by the Nova Scotia Department of Natural Resources, will significantly improve reporting on provincial woodlot harvests.

Eaton et al. (1986) reported that the practice of clearcutting over time may also be changing the species composition of Nova Scotia forests. For example, about one-third of the clearcuts on the Cape Breton Highlands had not regenerated adequately at that time. According to the Canadian Council of Forest Ministers (CCFM) technical report on sustainable forest management (CCFM 1997), white cedar and white pine were probably much more predominant historically, and their abundance has declined considerably during the past 200 years, probably due to forest harvesting and land clearing. Currently, the dominant species of Nova Scotia's forests are black spruce, red spruce, balsam fir, sugar and red maple, yellow and white birch, white spruce, tamarack, and trembling aspen.

The rate of cutting in Nova Scotia has doubled over the past two decades by *volume*, and in the last decade alone the actual *area* clearcut annually has doubled, placing additional stress on the province's forests. The wood volume harvested annually grew from an average of 3.3 million cubic metres between l981 and l985 (NSDNR l997) to 6.5 million in 2000 (NSDNR 2001).[31] Based on the annual growth rate of the province's forests and on the rate of seeding and planting in the past decade, the current annual rate of cutting is unsustainable.[32]

Apart from the introduction of forest guidelines, there is little evidence to date that consistent reports on declining forest quality and over-harvesting have had any substantial impact on forest policy or practices in the province. Indeed, the growing gap between evidence and policy, and the maintenance of financial incentives encouraging increased clearcutting and intensive forest management, indicate that the current economic value of timber continues to be the only real value considered in the policy arena.

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[31] For more detailed actual annual harvest information refer to Figure 18 in Volume 2 of the Forest Accounts.
[32] Ken Snow, Manager, Forest Inventory, NSDNR, notes that the NSDNR classifies the level of harvest on small, private woodlots as unsustainable, but does not apply that judgement to the province's forests as a whole (2001.)

The historical evidence indicates a clear and pressing need for a full-cost accounting mechanism that brings the full range of forest values directly into a core system of economic and resource accounts that can be used by the province:

- to assess forest health and integrity;
- to create a comprehensive strategy for protected areas;
- to assess and provide incentives for the restoration forestry now required;
- to craft a sustainable forestry policy based on regulations, incentives, ecosystem-based forestry practices, and conservation ecology; and
- to ensure a sustainable high quality wood supply for future generations.

5.2 Forest Type and Natural Disturbance Regimes

In Nova Scotia, the Acadian forest is a transition zone between the northern hardwood forest and the boreal forest (Loucks 1962). As a result the Acadian forest exhibits characteristics of both forest types.

Most northeasternly forests are commonly believed to have developed as a result of natural fire disturbances on a cyclical basis. However, there is increasing evidence that suggests that Acadian forests have been less influenced by large-scale disturbances. For example, the average time between major disturbances has been estimated by Lorimer (1977) to be every 800 to 1900 years. Along coastal regions, large-scale blow-downs by hurricanes were likely more frequent (Davis 1966).

Fires have had a significant effect on Nova Scotia's forests since European settlement, and were most often caused by humans (Strang 1972, Wein and Moore 1979). Native Americans periodically used fires to manage vegetation prior to the arrival of Europeans. More recently, burns have almost always been either intentionally set to assist with forest clearance or were accidental escapes from logging camps or communities close to woodlands (Wein and Moore 1979).

Therefore, the *natural* recurrence interval of large-scale disturbance is greater than the life span of dominant tree species. The evidence of an average 800-1900 time span between major disturbances is important in light of the frequent assertion that short-rotation (50-60 year cycle) clearcutting mimics natural disturbances.

In fact, gap phase dynamics are more of an influence in regeneration of the forest in this region than large-scale disturbance. Gap phase dynamics in a forest occur when a tree or several trees fall down and create an opening in the forest canopy. This opening promotes advanced tree growth and/or enables tree seedlings to grow into the middle and upper canopy to replace the trees that had blown over or died. Such a disturbance regime creates an uneven-aged forest or a forest composed of various ages with a dominance of old trees, a pattern far more characteristic of the original Acadian forest than the young even-aged stands that follow clearcutting.

Natural disturbance patterns are particularly important for forest management policy decisions regarding silviculture applications. Silviculture and logging methods can be used to promote different tree species (e.g. shade-tolerant or shade-intolerant trees), faster growth, and larger tree diameter. Clearcut logging results in an even-aged second growth forest, because the logging clears all the trees at one point in time.

As noted, clearcutting has been justified in the past not only because it is economically efficient, but also because it is said to emulate the natural disturbance of fire. However, there is little evidence that clearcutting does emulate the biophysical functions of fire. Even more basically, the scientific and historical evidence indicates that old-growth, multi-species, multi-aged forests are the natural forest type for Nova Scotia, not the even-aged second growth that clearcutting and current silviculture methods promote.

In the case of Nova Scotia, where predominantly small-scale natural forest disturbance historically occurred, selection harvest methods are more appropriate to emulate natural disturbance. Selection logging, based on the principles of ecosystem management, promotes an uneven-aged, multi-species forest in closer accord with historical forest succession patterns in this region.

According to the Ecological Society of America (ESA), ecosystem management must include the following principles:

- long-term sustainability as the fundamental value;
- clear, operational goals;
- sound ecological models and understanding;
- understanding the reality of complexity and interconnectedness;
- recognition of the dynamic character of ecosystems;
- attention to context and scale;
- acknowledgement of humans as ecosystem components; and
- commitment to adaptability and accountability.[33]

If the goal of good forest management is to emulate natural disturbance patterns, these principles would appear to be an essential part of that process.

5.3 Public Values of Nova Scotia's Forests

In a recent public opinion survey on Nova Scotia forests, *Public Perceptions and Attitudes Towards Forestry Issues*, Sanderson et. al. (1999) found that:

- 91% of Nova Scotians believe the present rate of timber harvest is too high to sustain the forest for other values or uses.
- 63% think there is insufficient wood in Central Nova Scotia for all users.
- A majority of respondents agree that the forest industry needs to do more to protect the environment even if this results in the loss of some jobs.

[33] http://esa.sdsc.edu/ecmtext.htm

- 90% feel the protection of the environment is more important than protecting jobs in the forest industry.
- 89% agree that legislation is necessary to ensure that forest landowners adhere to best forest management practices.
- A majority believe that clearcutting should not be used as a harvest method in Central Nova Scotia because it harms wildlife, ruins forests, causes erosion, looks bad, and wastes wood.

5.4 Basic Statistics on Nova Scotia Forests

Forest Resource

Total Area	5.6 million ha
Land Area	5.3 million ha
Forest Land	4.2 million ha

Ownership of Forest Land

Provincial	28 %
Federal	3 %
Private	69 %

Forest Type[34]

Softwood	54.4 %
Hardwood	12.6 %
Mixed wood	24.5 %
Other[35]	8%

6. Definitions & Data Sources

6.1 Natural Capital, Flows, and Services

> *"One additional way to think about the value of ecosystem services is to determine what it would cost to replicate them in a technologically produced, artificial biosphere. Experience with space missions and Biosphere II indicates that this is exceedingly complex and expensive. Biosphere I (the Earth) is a very efficient, least-cost provider of human life-support services"* (Costanza et. al. 1997).

[34] Source: Nova Scotia Department of Natural Resources GIS inventory data (1999).
[35] "Other" refers to clearcut and regenerating stands for which dominant tree species cannot be determined by aerial photography because of their small size (NSDNR pers. comm.).

Capital generally refers to the *stock* of materials or information available at a given point in time (Costanza et. al. 1997). *Flows* include the extractions or harvests from a stock and the ecological services rendered by the stock. Ecosystem services are the flows of materials, energy and information from natural capital stocks. If the amount taken from a stock does not exceed the stock's growth rate, then, in theory, the flow rate perpetuates through time (Prugh 1995). The integrity and value of the capital stock depends on maintaining its quality as well as its quantity.

Forest ecosystems are actually complex life-sustaining systems that contain many different stocks, - not only the timber or wood stocks that are often mistakenly equated with forest stocks. Therefore, a complex set of criteria and indicators must be used to measure the quantity and quality of available forest stocks, and of the changes over time in the flows or services provided by these stocks. Such an accounting mechanism is essential in order to assess whether a particular flow of services leaves the original natural capital intact.

6.2 Net Present Value, Ecosystem Values, and Discounting

Assessing the economic value of natural capital stocks and flows in monetary terms is even more complex than providing such descriptions in physical and qualitative terms. While timber values are well documented in monetary terms, other vital ecosystem functions and services have long been taken for granted as "free," and neither their economic value nor the cost of their loss have conventionally been assessed in economic terms.

Discounting is a standard procedure used in business economics to assess the net present value of anticipated future benefits and costs, and is based on the assumption that individuals favour current income over future income. Using standard discounting methods, the current monetary value of a given ecosystem function could, therefore, potentially be assessed in terms of the average annual return provided by the capital stock over time. In essence, the higher the discount rate, the greater the preference for current consumption over future investment . A low discount rate implies correspondingly greater worth assigned to the interests of future generations. The current literature on the value of environmental functions generally uses a 5%-6% discount rate.[36]

There are serious objections to the use of discounting, as used in business economics, to assess ecological values, because of fundamental differences in the nature of manufactured and natural capital. While the former inevitably depreciates in value, natural capital or ecosystems do not need inputs from humans, and they can provide goods and services in perpetuity. Because natural capital benefits last indefinitely, the economic "lifetime" of man-made goods and services, which generally lose their value after 20 or so years, is deemed an inappropriate standard for assessments of environmental value.

Effectively, a discount rate of 5% means that the net present value of any given ecosystem function is near zero just 30 or 40 years hence. Critics therefore argue that discounting not only

[36] For an excellent discussion of discounting practices in environmental accounting, see Asian Development Bank, 1996, *Economic Valuation of Environmental Impacts: A Workbook,* Manila.

ignores the reality that ecosystem services can potentially provide the same benefits indefinitely, but also fails to take into account the interests of future generations and their stake in a healthy environment. By contrast, these critics point out, a more appropriate model is the practice of some native communities to have an elder representing the seventh generation hence participate in all important decisions, thereby placing the interests of future generations on an equal footing with current well-being.

Finally, critics argue that human or man-made capital providing goods and services are replaceable, while natural ecosystems are not, and that discounting implicitly and mistakenly assumes that future generations will have the option of re-investing in natural capital.

Other ecological economists have suggested an entirely different approach to natural capital accounting that avoids discounting and still allows comparison with manufactured capital assessments. This is the "interest-on-capital" approach that assesses sustainable use according to whether extraction and harvesting rates allow societies to live on the "interest" represented by the natural growth rates and capacity to provide services, without any depletion of capital stocks.

Unlike the "net present value" assessments described above, this approach does not assume that natural capital stocks are replaceable or can be substituted by manufactured capital, because the essential benchmark is the maintenance of the original stock. In addition, annual return is seen as the continued interest on the capital stock without any implied time limit to benefits provided. This initial report uses indicators for forest value measurements rather than natural capital accounting. Thus, the application of discount rates is not in question. In some cases, existing environmental valuations are simply adapted from the ecological economics literature and applied to Nova Scotia forests where there is some potential basis for comparability.

For the present, greater emphasis is placed here on the physical and qualitative indicators and descriptors that form the basis of measuring sustainable resource use. . Because many of these vital statistics have not previously been assembled in one place, this study focuses on laying that necessary ground for potential future studies on the value of Nova Scotia's forests and on a full-cost accounting of their use.

6.3 Data Sources

Data on Nova Scotia forests, including harvest areas and volumes; age and species structure; employment, industry and economic data; and other information used to construct the tables and charts in this report, are primarily from the following sources:

(a) Canadian Forest Service, Natural Resources Canada, *National Forestry Database*
(b) Nova Scotia Department of Natural Resources, September 1999. *Updated 1995 Forest Inventory Data* (http://www.gov.ns.ca/natr/forestry/inventory/); Ken Snow, personal communication).
(c) Hawboldt, L.S., and Bulmer, R.M. 1958. *The Forest Resources of Nova Scotia*. Department of Lands and Forests. Province of Nova Scotia.

(d) Nova Scotia Department of Natural Resources. 1973. Information Report: Forest Inventory Provincial Summary l965-l971. Forest Planning Division. Truro, Nova Scotia.
(e) Nova Scotia Department of Natural Resources, 1983. *Information Report: Forest Inventory Provincial Summary 1975-1982*. Forest Resources Planning and Mensuration Division. Truro, Nova Scotia.
(f) Nova Scotia Department of Natural Resources, 1987. *Information Report: Forest Inventory Provincial Summary 1976-1985*. Forest Resources Planning and Mensuration Division. Truro, Nova Scotia.
(g) Nova Scotia Department of Natural Resources, 1991. *Information Report: Forest Inventory Provincial Summary 1979-1989.* Forest Resources Planning and Mensuration Division. Truro, Nova Scotia.
(h) Statistics Canada, *Logging Industry*. Catalogue No. 25-201-XPB
(i) Statistics Canada Catalogue No. 25-202.
(j) E.S. Atkins. 1965. *Forestry Projections: Comparison of the Three Methods of Projection*. Department of Natural Resources. 07-64-0021-01.
(k) Nova Scotia Department of Finance. 1998. *Nova Scotia Statistical Review*. 15th edition. Statistics Division. Halifax, Nova Scotia.

Other sources are cited in the references and bibliography at the end of this study. However, every attempt has been made to rely on the official and government sources listed here for all essential calculations, both in the interests of transparency and to allow information to be checked for accuracy. As well, this procedure will allow any other province or jurisdiction in Canada that is interested in constructing its own forest and other natural resource accounts to access comparable data sources.

6.3.1 A note on conflicting sources for recent volume, age, and species data

The most recent inventory data for age class distribution in Nova Scotia were available from two sources: The Geographic Information System (GIS) Forest Inventory (l995) and the Nova Scotia Forest Inventory Based on Forest Inventory Permanent Sample Plots (PSP) Measured between l994 and l998.

According to the NSDNR (l999), the methodology of inventory collection has changed several times since l953. Field strip cruises have been replaced today by a combination of field sampling and photo interpretation. The most recent forest inventory was derived from aerial photography (between l985 and l993) and photo interpretation of the province's two million stands, which is verified by field sampling.

When comparing forest inventories from one measurement period to the next, it must be kept in mind that not only does methodology change from one inventory to the next, but *what* is measured changes as well. For instance, what was considered "merchantable" in l958 was likely of a much larger diameter than what is considered "merchantable" today.

In addition to the GIS forest inventory, the NSDNR maintains approximately 2,000 Permanent Sample Plots randomly placed across the province. This system, in place since l965, was "designed to track volume growth and mortality of the natural forest" (NSDNR l999). l994-l998 was the first time that PSP data were used for a forest inventory. Prior to that, the only publicly available PSP data measured Periodic Annual Increments.

For the most recent data in assessing trends in age class distribution, total merchantable volume, and species volume, the GPI Forest Accounts have used the GIS Forest Inventory rather than the PSP data for the following reasons:

- In order to track trends over a 40-year period, data were required that could be compared readily with inventories dating from 1958 to l989. PSP data could not be used for that purpose, because they had not been used for forest inventory purposes prior to 1994-1998 but only to assess Periodic Annual Increments.
- PSP data are limited to 2,000 plots. In order to extrapolate the measurements on these plots to the province as a whole, it must assumed that the plots are treated in exactly same manner as the surrounding lands. Ken Snow, Manager of Forest Inventory at the NSDNR, states that any protected stands would be eliminated from the sample. However, there are no field studies that assess whether these permanent plots are given preferential treatment and are in fact representative of Nova Scotia as a whole.
- GIS data is used by the NSDNR itself in its Strategic Analysis of Wood Supply (SAWS) modelling to determine harvest levels. It is also used (in preference to the PSP data) by the Department's Parks and Protected Areas Division.

Conflicting numbers in the most recent PSP and GIS data raise questions regarding the accuracy of the recorded data. For example:

- The overall merchantable volume for the province using PSP data is estimated at 411 million cubic metres, 4.5% higher than the figure generated by the GIS forest database.
- Forests older than 100 years are estimated by PSP data to cover 5.5% of the province's forest area while GIS data state they cover only 0.15%.
- Forests between 80-100 years account for 14% of the province's forests according to PSP data, and 0.9% in the GIS data.

There are numerous other examples where the GIS and PSP numbers do not match. The fact that the permanent sample plots in each of the examples show higher volumes and proportions of old trees, indicates that they are possibly not being harvested at the same rate as adjoining lands.

Comparisons with earlier forest inventories provide further evidence that the PSP numbers are likely highly exaggerated. For example, forests 80-100 years old covered 8% of forest area in the 1975-82 inventory, 5% in the 1976-85 inventory, 3% in the 1979-89 inventory, and 1% in the 1995 GIS inventory. There is a consistent trend here in several forest inventories that sharply contradicts the PSP estimates.

Forests over 100 years accounted for 2% of forest area in the 1975-82 forest inventory, 1% in the 1976-85 inventory, and less than 1% in the 1979-89 and 1995 inventories. The GIS figures, again, are therefore consistent with historical trends using other inventory methods. The PSP data are contradicted by simple logic: Given the trends in the 80-100 year old age class, it is physically impossible for the over 100 age class suddenly to be five times greater than it was 20 years ago, as the PSP data imply.

Ken Snow, Manager, Forest Inventory, NSDNR, (2001) states: "For the latest information on Inventories investigators should use the PSP data for age class distribution and species diversity. For cover type data etc and area data the GIS inventory should be used."

However, the substantial conflict with historical trends demonstrated above indicates that PSP data may be not appropriate for estimating province-wide age class distribution. Nor does it currently appear possible to use the PSP data to assess trends over time. In the absence of a reconciliation of the conflicting evidence, or at least a credible explanation of the data disparities, there remain serious doubts on the utility of the PSP data as a reliable source of province-wide volume, age and species projections.

Given the remarkable consistency of the historical inventory data in demonstrating age class trends in sharp contradiction to the current PSP data, it appears much more likely, from the evidence presented above, that the permanent sampling plots are not being cut at the same rate as their adjoining lands. GPI Atlantic strongly recommends that field tests be undertaken by an independent assessor to compare stocking levels, age and species distribution, and harvest dates on permanent sampling plots in relation to nearby lands.

Because of these prevailing uncertainties, and because of the need to assess historical trends using data comparable to earlier forest inventories, and the fact that the NSDNR itself uses the GIS data for its wood supply projections, the GPI forest accounts rely on the GIS inventory for the most recent volume, age, and species data.

PART II

NOVA SCOTIA FOREST ECOSYSTEM VALUES

The following six chapters in Part II are adapted from the criteria and indicators of the Canadian Council of Forest Ministers guidelines for sustainable forest practices in Canada, and also the standards of the internationally agreed Montreal Process (the 10-nation Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests that includes Canada). As noted earlier, these criteria and indicators have been adopted as the framework for this study, which attempts to apply these agreed standards in practice by assessing Nova Scotia's actual current compliance.

In many cases, data are not currently available to assess the state of Nova Scotia forests according to these criteria and indicators. Nevertheless, GPI Atlantic accepts that these two sets of nationally and internationally agreed criteria and indicators provide a reasonable and adequate description of forest functions and values, and thus provide a suitable framework for any set of physical forest accounts in Canada. For this reason, and in order to help provide a template for future development of forest accounts, the sub-headings below represent that full framework even when data are inadequate, not readily available, or non-existent.

It is therefore acknowledged that many data sets provided below are incomplete, and there are many cases where the text following the sub-heading simply indicates that provincial data for that particular indicator are not yet available. GPI Atlantic therefore regards this study as a "work-in-progress" with one of its major functions being the identification of current data gaps. While this procedure and method may sacrifice flow and readability in many instances, we are convinced that this "bottom-up" process can provide a greater contribution to future assessments of forest value than a premature, comprehensive and “top-down” economic valuation based on inadequate data.

In essence the purpose of the following chapters is to make a contribution to the stated goal of the World Commission on Forests and Sustainable Development as cited in the frontispiece, - to create a workable measure of forest values, integrity and health. It also aims to see the Canadian Council of Forest Ministers (CCFM) criteria and indicators applied in practice. If Nova Scotia can take a lead in that endeavour, not only in theory, but through its actual forest practices and policies, such a model can bring considerable long-term benefits to the province.

7. Conservation of Biological Diversity

7.1 Ecosystem Diversity

Age, structure, species, and genetic diversity are major components of forest ecosystem diversity. In order to assess the ecosystem diversity of Nova Scotia's forests, this section, corresponding to a major set of CCFM criteria and indicators, considers:

- the area of old-growth or primary forests in Nova Scotia;
- the age diversity of Nova Scotia forests using inventory data;

- protected areas;
- forest access and fragmentation; and
- species diversity.

Biological diversity is important for the maintenance of ecosystem functions, which provide habitat for wildlife and essential services for humans. For example, the biological diversity of the world's ecosystems provides the following essential functions and services (Pimentel et. al. 1997):

- provision of biomass;
- recycling of organic wastes;
- soil creation;
- fixing of vital nitrogen;
- bioremediation of chemical pollution;
- provision of genetic resources that increase crop and livestock yields;
- natural pest control;
- provision of the dominant perennial cereal grains;
- support for ecotourism;
- harvest of wild foods and pharmaceuticals; and
- sequestration of carbon dioxide.

Pimentel et. al. (1997) estimate that the annual economic and environmental benefits of biodiversity in the United States total approximately $300 billion.

The economic value of biodiversity in Nova Scotia forests is not assessed as an aggregate in this study because valuation data on many of the above functions are not available, nor is it necessary to place a dollar value on all of them. However, a few examples indicate clearly that restoring and maintaining the natural ecosystem diversity (e.g. age and species composition) of the primary natural forests of Nova Scotia has direct economic and monetary value. For example:

- Old growth and mature trees provide lumber with larger diameter logs and clear rather than knotty lumber, both of which fetch premium prices in the market economy.[37]

- Old growth ecosystems store large amounts of carbon in biomass, and soils. When clearcut, large amounts of carbon stored in trunks, branches, roots, and soils are lost, released as carbon dioxide to the atmosphere.[38]

- Loss of natural species diversity may produce a decline in the market value of timber due to loss of valuable tree species. It also increases the reliance of forest-dependent communities on fewer products (i.e. a less diverse economic base). For example, the Canadian Council of Forest Ministers' technical report on sustainable forest management (CCFM 1997) notes a significant decline in the abundance of white cedar and white pine in Nova Scotia due to 200 years of forest harvesting. Market prices can be assessed to

[37] For this analysis, see Volume 2 of these Forest Accounts, Chapter 8.
[38] See Chapter 10 for a detailed discussion on the impacts of age structure and forest conversion on carbon storage and carbon losses. See also Schulze et. al. (2000); Harmon et. al. (1990); and Fleming and Freedman (1998.)

determine whether changes in species composition have reduced the net value of Nova Scotia timber over time.[39]

- The natural mixed composition of species in Nova Scotia's forests can increase forest resilience and reduce susceptibility to spruce budworm and other insect and disease infestation, thus protecting timber values.
- The burgeoning Nova Scotia tourism industry is largely dependent on the province's natural attractions, with older, varied forests providing pleasing landscapes for tourists and habitat for wildlife that younger, single-aged forests cannot provide.
- There is evidence that natural species diversity can enhance soil quality and thus improve timber productivity. For example, a British Columbia study found vital linkages between natural species diversity, presence of fungi, soil quality, and rate of tree growth. Simard et. al. (1997) found that hardwood species, such as white birch, transfer carbon resources through below-ground mycorrhizal fungi to softwood seedlings, such as Douglas fir, which are establishing under the shade of faster-growing hardwoods. This is important, because seedlings rich in ectomycorrhizae have the greatest net transfer of carbon, resulting in better growth.

Although this is by no means a complete list of the economic benefits of biodiversity in Nova Scotia forests, these few examples illustrate that the diversity of natural forest ecosystems has both direct and indirect economic value. Where possible, this report attempts to elucidate some of these environmental-economic linkages on the basis of the available evidence. However, the primary framework for the analysis remains the physical indicators in the CCFM and Montreal Process guidelines.

7.1.1 Percentage and extent, in area, of forest types relative to the historical condition and total forest area

True old-growth forest (>150 years old) in Nova Scotia is endangered and exists only in very small, scattered, isolated pockets in the province. Even old forest (> 100 years old) today covers only 0.15% of forested land. These age-groups probably once dominated the landscape (Lynds and LeDuc 1995). We are currently witnessing the disappearance of the natural site-evolved species, structure, and age characteristics of the once dominant Acadian forest.

The very few remnant old forest stands contain the only remaining genetic and structural information we now have of the original Acadian forest landscape in Nova Scotia. However, the ecological integrity of these isolated remnant stands is threatened because they are highly fragmented and very small in area. These factors make it difficult for forest ecosystems to

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[39] That analysis has not been undertaken for this report, but should definitely be included in future updates. The analysis of comparative prices for large diameter and clear lumber compared to small diameter, knotty lumber in Volume 2, Chapter 8, is a suitable model for a similar comparative analysis to assess market prices for species that have declined in abundance compared to prices for those that have increased in abundance. The results can then be extrapolated for the province as a whole to assess changes over time in the market value of standing timber in Nova Scotia's forests.

function effectively, and to maintain their natural genetic and structural integrity. They become more susceptible to invasions of non-native species.

Regionally, only 3% of old forests more than 120 years old remain in the entire Atlantic Maritime ecozone (CCFM 1997). Overall, therefore, Acadian and Atlantic Maritime forests today bear little resemblance to their natural age diversity prior to European settlement.

7.1.2 Percentage and extent of area by forest type and age class

Provincial Forest Age Class Distribution

Figures 1 through 7 demonstrate the sharp decline in the percentage of forest aged 61 to over 100 years old that has occurred since the 1950s alone. It must be borne in mind that Nova Scotia did not have pristine forests in 1958, and that the authors of the 1958 inventory report pointed to serious degradation that had already taken place (Hawboldt and Bulmer 1958). Yet as recently as 1958, nearly 60% of the province’s forest area was still covered by forests more than 60 years old. Today, only 12% of provincial forestland is greater than 60 years old.

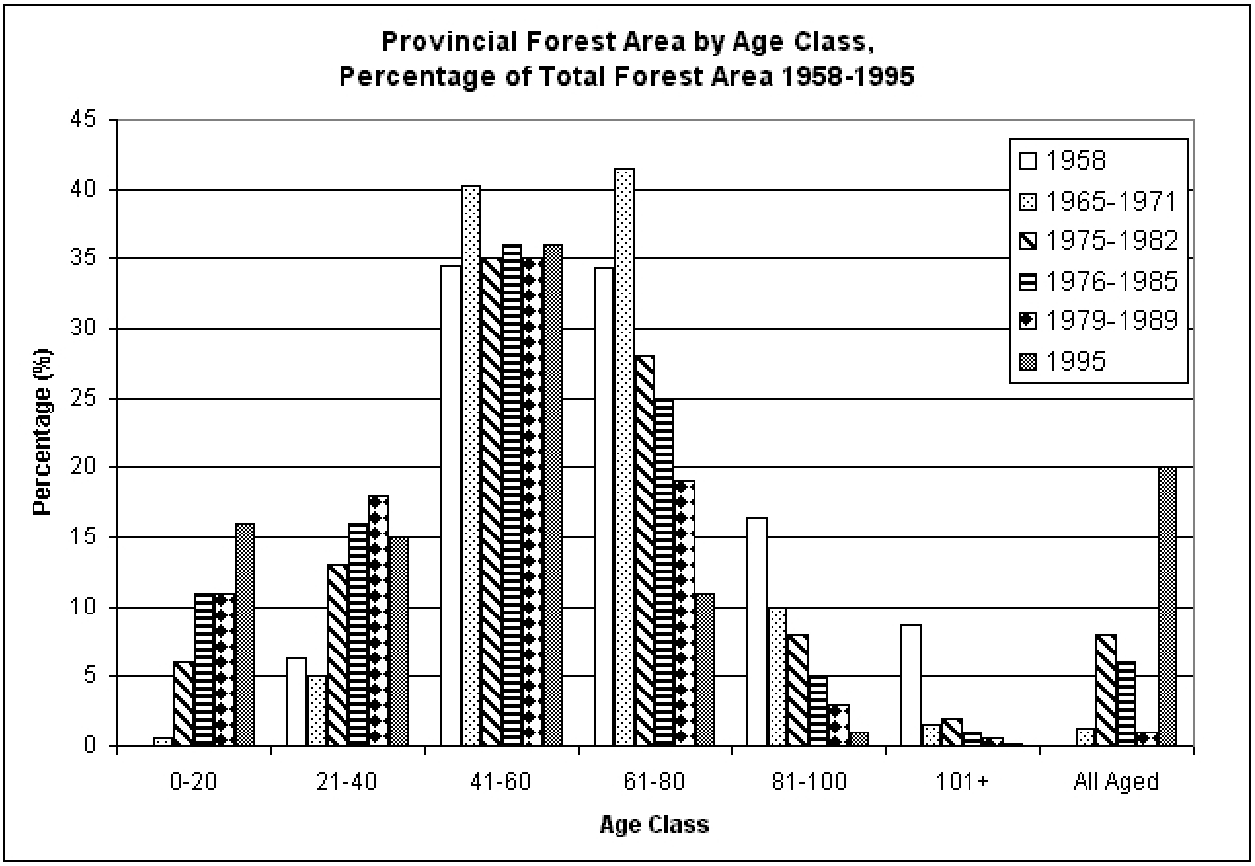
The percentage of Nova Scotia forests classified as 61 to 80 years was approximately 34% in 1958, 27% in 1982, 25% in 1985, and 19% in 1989, with the most recent inventory in 1995 indicating only 11% of forests remaining in this age class. The up-to-20-years age class, which is growing rapidly, reflects the area that has been clearcut, resetting the stand age to zero with subsequent regenerating stands.

The forest area represented in the older age classes (80 years plus) has decreased even more dramatically since 1958 (Figures 1 through 7). The 81 to 100 year old forests have dropped from approximately 16% in 1958 to 0.9% in 1995. The forests over 101 years have declined from approximately 8% in 1958 to 0.15% in 1995. Thus, in the last 40 years, there has been a 5-fold decline in forests over 60 years old; a 25-fold decline in forests over 80; and a more than 50-fold decline in forests over 100 years old.

Expressed as a percentage decline, the 61 to 80 year-old age class has dropped by 68% since 1958; the 81 to 100 year-old age class by 94%; and the 101+ year-old age class by 98%. At the same time, the percentage of young forest "up-to-age 20" has increased by 170% over the same period, and the 21 to 40 year-old age class has increased by 150%.

In sum, the Nova Scotia forest landscape has changed dramatically in a very short period, with a significant loss in age diversity, and a sharp shift from older to younger age classes. Nova Scotia’s forests have become very much younger. In 1958, nearly one-quarter of Nova Scotia forests were in the over 80 age class, declining to just 1% forty years later, while young forests (up to age 40) more than doubled from just 12% of the total in 1958 to more than 30% today. In other words, *the province has lost almost all of its remaining old forests in the last 40 years alone*, with old trees cut down and replaced by young saplings.

Figure 1. Provincial Forest Area by Age Class, Percentage of Total Forest Area, 1958-1995

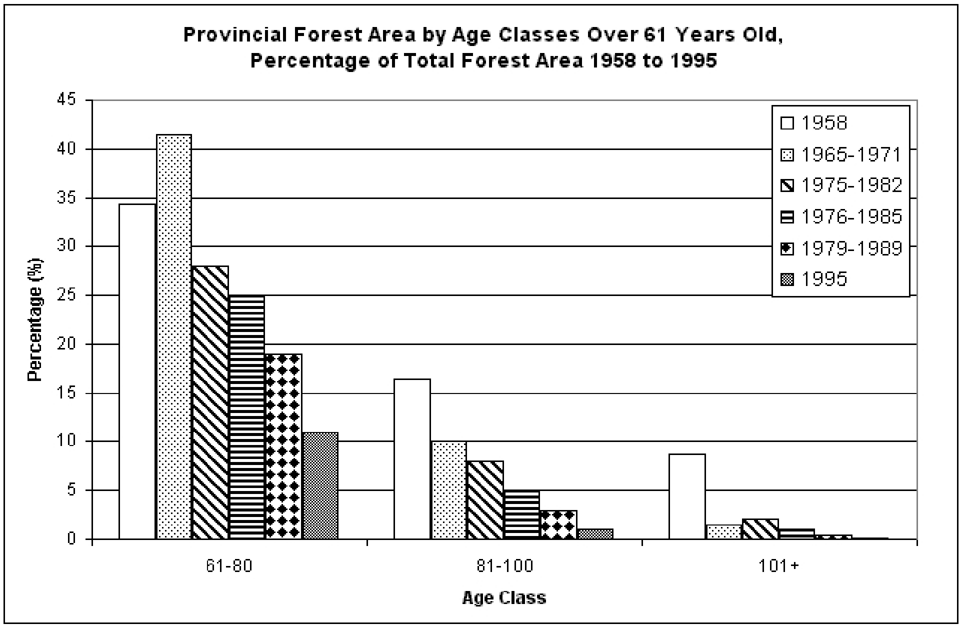


Sources: The Forest Resources of Nova Scotia, 1958; DNR Information Report: Nova Scotia Forest Inventory Provincial Summary 1965-1971, 1975-1982, 1976-1985, 1979-1989; and DNR GIS 1995 Inventory Data, September 1999 update.

1958 is taken as the benchmark year in these estimates, only because it provides the earliest comparable inventory data set. As noted above, however, the 1958 figures by no means represent a pristine, unspoiled, or natural forest. As outlined in the historical overview (5.1 above,) the 1958 forest survey conducted by the provincial Department of Lands and Forests observed that Nova Scotia had already lost most of its primary forest by that year and had increased the land area covered in non-commercial and low-value species. It also noted that forests had suffered greater insect damages due to the loss in diversity (Hawboldt and Bulmer 1958).

Even the first provincial forest survey in 1912 found the province's forests already depleted. When the 1995 figures on age diversity are considered against the background both of the old-growth Acadian forest that was the original dominant forest type in the province, and of more than 200 years of logging, then the loss in age diversity from natural conditions is far more dramatic than Figure 1 indicates. We can only speculate on the shape of Figure 1 if the years 1800 and 1900 were included in the presentation. What is remarkable, given the comparatively short time-span of the chart, is the almost complete loss of the remaining old forests in the province in a single generation.

Figure 2. Provincial Forest Area by Age Classes Over 61 Years Old, Percentage of Total Forest Area, 1958-1995

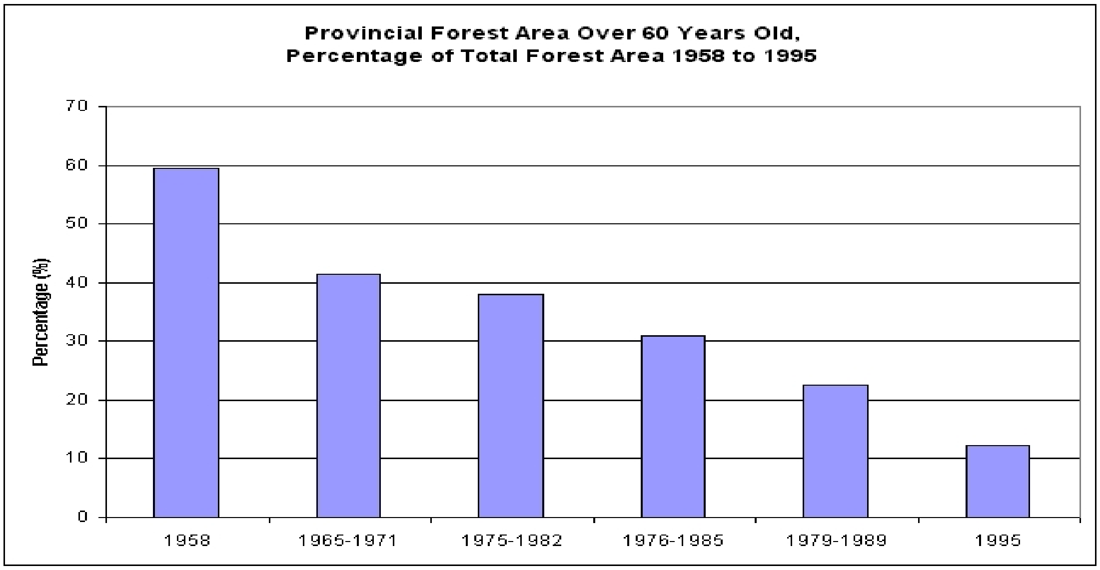


Sources: The Forest Resources of Nova Scotia, 1958; DNR Information Report: Nova Scotia Forest Inventory Provincial Summary 1965-1971, 1975-1982, 1976-1985, 1979-1989; and DNR GIS 1995 Inventory Data, September 1999 update.

Figure 3. Provincial Forest Area by Age Classes up to 40 Years Old, Percentage of Total Forest Area, 1958-1995

Sources: The Forest Resources of Nova Scotia, 1958; DNR Information Report: Nova Scotia Forest Inventory Provincial Summary 1965-1971, 1975-1982, 1976-1985, 1979-1989; and DNR GIS 1995 Inventory Data, September 1999 update.

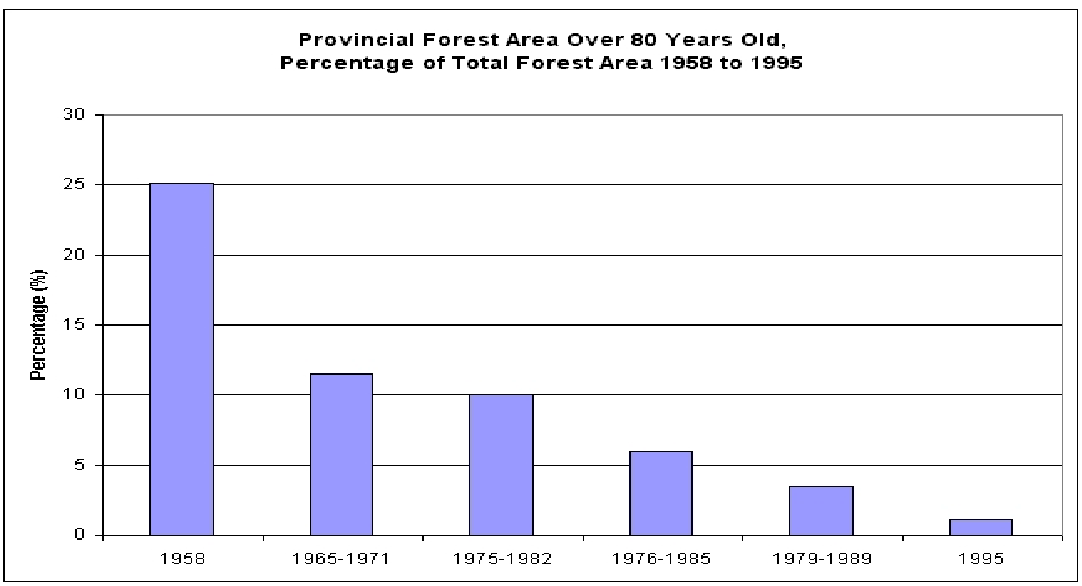
Figure 4. Provincial Forest Area Over 60 Years Old, Percentage of Total Forest Area, 1958-1995



Sources: The Forest Resources of Nova Scotia, 1958; DNR Information Report: Nova Scotia Forest Inventory Provincial Summary 1965-1971, 1975-1982, 1976-1985, 1979-1989; and DNR GIS 1995 Inventory Data, September 1999 update.

Note: "Over 60 Years Old" refers to the combined total of trees in three age classes: 61-80 years old, 80-100 years old and 101+ years old.

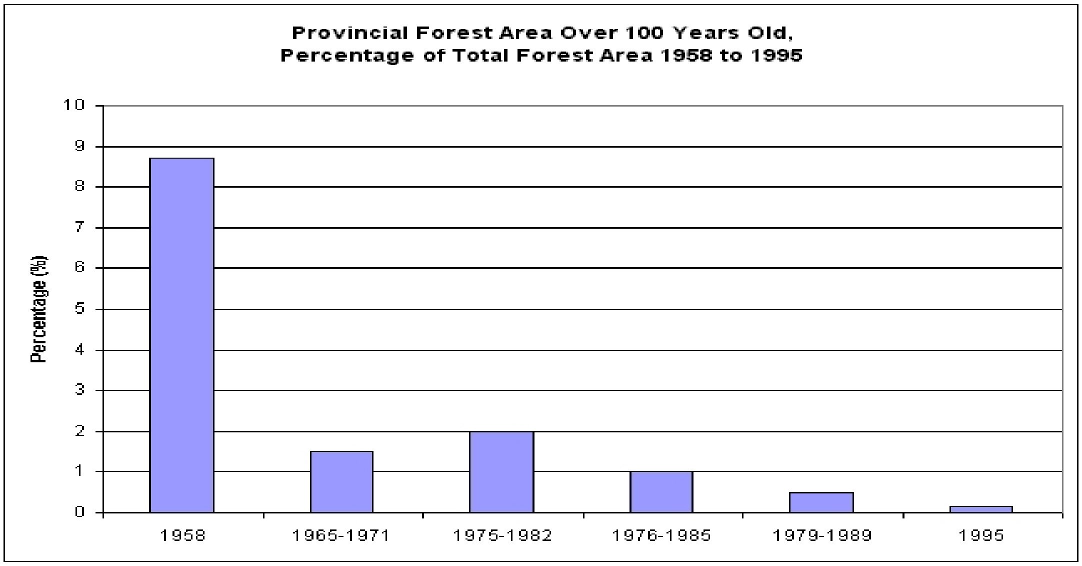
Figure 5. Provincial Forest Area Over 80 Years Old, Percentage of Total Forest Area, 1958-1995



Sources: The Forest Resources of Nova Scotia, 1958; DNR Information Report: Nova Scotia Forest Inventory Provincial Summary 1965-1971, 1975-1982, 1976-1985, 1979-1989; and DNR GIS 1995 Inventory Data, September 1999 update.

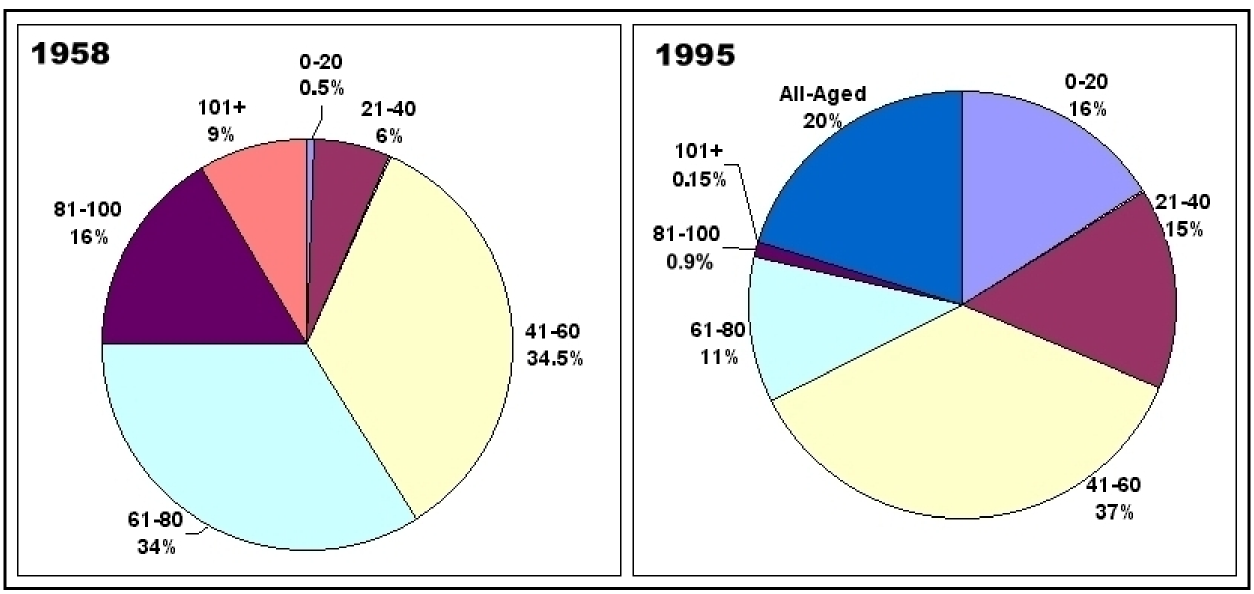
Note: "Over 80 Years Old" refers to the combined total of trees in two age classes: 80-100 years old and 101+ years old.

Figure 6. Provincial Forest Area Over 100 Years Old, Percentage of Total Forest Area, 1958-1995



Sources: The Forest Resources of Nova Scotia, 1958; DNR Information Report: Nova Scotia Forest Inventory Provincial Summary 1965-1971, 1975-1982, 1976-1985, 1979-1989; and DNR GIS 1995 Inventory Data, September 1999 update.

Figure 7. Changes in Nova Scotia Forest Age Structure, 1958-1995



Sources: The Forest Resources of Nova Scotia, 1958; DNR Information Report: Nova Scotia Forest Inventory Provincial Summary 1965-1971, 1975-1982, 1976-1985, 1979-1989; and DNR GIS 1995 Inventory Data, September 1999 update.

The dimensions of the change in relation to the Acadian forest that once existed in Nova Scotia may be realized by comparing the natural age limits of common Maritime tree species with the age structure documented in the most recent forest inventory. By comparison, we have come a very long way from a “natural” forest. Here are the natural age limits for common species in this region:

White Ash	100-200	Red Oak	200-350
American Beech	300-400	Red Pine	200-250
White Birch	120-150	White Pine	200-450
Yellow Birch	150-250	Black Spruce	200-250
Red Maple	100-150	Red Spruce	250-400
Sugar Maple	300-400	White Spruce	150-200
Eastern Hemlock	300-800		

Figure 1 indicates that the forest area classified as "all aged" has dramatically increased since the 1979-89 forest inventory. All-aged stands are defined as those with more than two distinct canopy layers. The reasons for this sharp increase in area in only 10 years are not yet clear, according to the Nova Scotia Department of Natural Resources (NSDNR). However, DNR staff believes that the number has been over-estimated (K. Snow pers. comm. 2001).

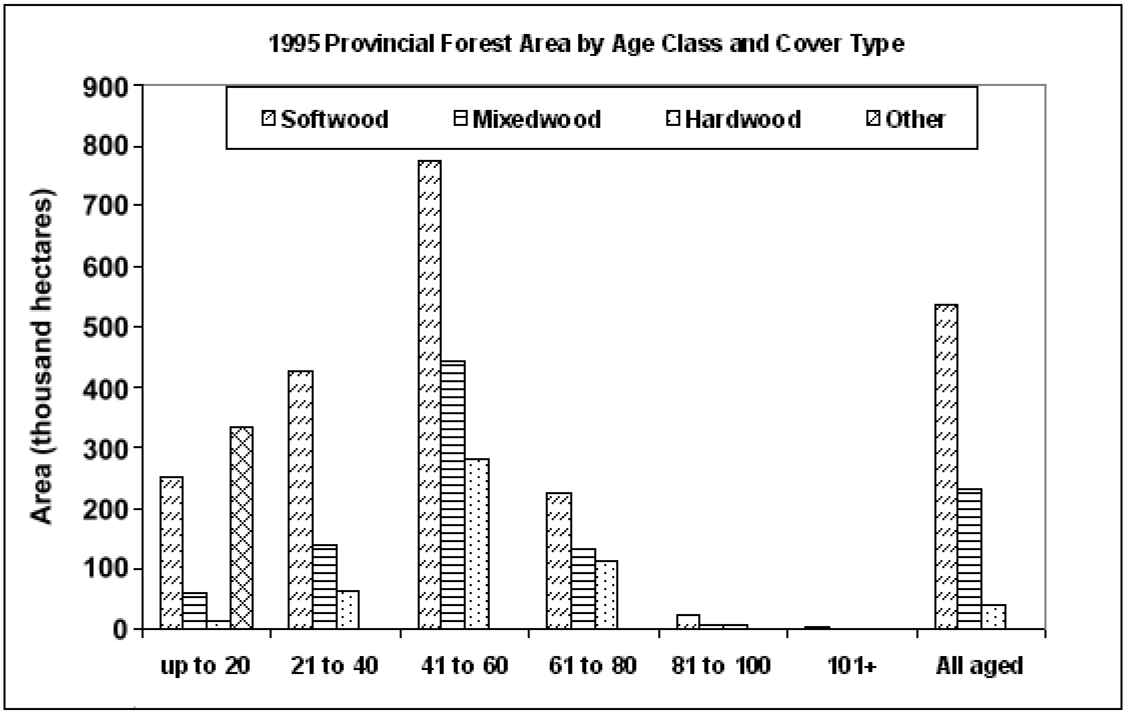
In addition, NSDNR staff speculates that a large portion of these types of stand structure result from past "high-grading" practices. Prior to 1975, woodlot operators would harvest the mature trees and leave the smaller ones behind, usually taking the biggest and best. When this type of harvesting is conducted over several decades, what is left is a multi-layered canopy of poor quality trees, which provide poor seed stock resulting in a general degradation of the tree stock. (NSNDR pers. comm.). By contrast, true selection harvesting prevents degradation by ensuring that good quality trees are left on a site or adjacent to a site as a seed source for the next generation.

In Figure 8, the most recent forest inventory demonstrates that a large percentage of the forest area less than 20 years old is classified as "Other" cover type. "Other" cover type refers to clearcut and regenerating stands for which dominant tree species cannot be determined by aerial photography because of their small size (NSDNR pers. comm.). Figure 8 also illustrates the current dominance of softwood stands in Nova Scotia. Originally, mixed and hardwood forest types were also dominant, but they have dramatically declined since European settlement.

7.1.3 Representation of forest types in protected areas

A February 1999 Environics poll found that Atlantic Canadians place a high priority on wildlife and habitat values. The poll concluded that people residing in the Atlantic region are among the most concerned about wildlife and habitat protection in the country. In fact, 71% of Atlantic Canadians encouraged their governments to honour their commitments to complete representation of all provincial landscape types by the year 2000. All provincial governments have signed on to the Endangered Spaces Campaign, a World Wildlife Fund initiative to ensure the completion of a network of all Canada's terrestrial regions to be protected by the new millennium. The goal of the campaign, agreed to by all governments, is to ensure that none of Canada's designated landscape and habitat types disappear.

Figure 8. Provincial Forest Area by Age Class and Cover Type, 1995



Source: Nova Scotia DNR, September 1999 Inventory Updates.

In Nova Scotia, 80 natural landscapes[40] have been delineated to describe the full range of large-scale variation in landforms, vegetation communities, natural disturbance regimes, local climate, and biodiversity across the province (NSDOE, 2000). The Province of Nova Scotia has committed to make every effort to protect representative examples of each natural landscape in a network of protected areas (NSDNR, 1994). Because more than 70% of Nova Scotia's land is privately owned, the cooperation of landowners is essential to fulfil the goals of this campaign.

To enable the completion of a network of protected areas, the World Wildlife Fund states that:

a) governments need to provide incentives to private landowners (e.g. appropriate property taxes) that promote and recognize the ecological and economic values of conserving forested areas;
b) corporations are asked to do their part by protecting a portion of their holdings; and
c) individuals or small property owners can help by contacting a local nature trust, such as the Nova Scotia Nature Trust, to assess their property's ecological values and to place a conservation easement on their natural heritage.

[40] The Nova Scotia Department of Natural Resources now uses 35 "eco-districts" in its Integrated Resource Management (IRM) planning process, which is a multiple-use planning process for Provincial Crown lands. The Department of Environment and Labour uses the 80 "natural landscapes" for provincial protected area planning and management processes, and for assessing the level of landscape representation with protected areas (David MacKinnon. 2001. pers. comm.).

In 1995, Nova Scotia protected 31 new wilderness areas, thus significantly increasing the number and area of protected representative natural areas. Table 4 illustrates the increase in protected areas over the last 10 years. Presently 29% to 33% of Nova Scotia's landscapes are represented in the province's network of protected areas, still far short of the Endangered Species Campaign goal, but substantially better than the 7% protected prior to 1995.

Table 4. Protection of Nova Scotia's Crown Land Natural Areas

	1990	1994	1995	1998
Parks & Protected Areas (thousand hectares)	138.7	161	448	453
Landscape Types Satisfactorily Represented within the Parks & Protected Areas (# out of 80):				
(a) according to World Wildlife Fund		7	23	23
(b) according to NSDNR		7	26	26
Percentage of Total Landscape Types (80) with Satisfactory Representation Protection:				
(a) according to World Wildlife Fund		8.75%	28.75%	28.75%
(b) according to NSDNR			32.5%	32.5%

Source: Nova Scotia Counts 1996-1997, Department of Natural Resources.

However, only 8.1% of the province's total forest area is currently under some form of protection (Table 5). This too is an improvement since 1995 but still well below the minimum of 12% recommended by the World Wildlife Fund.[41] Prior to 1995, the Atlantic Maritime ecozone as a whole had approximately 1.5% of its forest area strictly protected and another 5% under other types of lesser protection.

In l992 the provincial government made a commitment to protect a representative sample of each of the province's regions by the year 2000. To date, 23 out of a total of 89 of these regions have been adequately protected. According to the NSDNR, the large proportion of privately-owned land in the province makes the issue of protecting lands more challenging. Gerry Joudrey, regional director for the Western Region of the Integrated Resource Management (IRM) process, says many landscapes are not adequately represented because there isn't enough Crown land. "It's impossible in a lot of the landscapes to get the wilderness areas we would like. Over time maybe private land will be purchased" (G. Joudrey pers. comm. 2000). Despite Joudrey's suggestions that no new Crown land was available for protection, detailed proposals from hunting, fishing, wildlife and environmental groups for the protection of twenty new areas on Crown land in the province were submitted to the NSDNR (K. deGooyer pers. comm. 2001). Not one of these was adopted in the IRM plan unveiled by the NSDNR in the fall of 2000.

David MacKinnon, NS Department of Environment (pers. comm. 2001) noted that the GPI Forest Accounts (Volume 1) do not sufficiently acknowledge the vital need for protected areas.

[41] While WWF recommends 12% protection, it has been suggested (D. MacKinnon pers. comm 2001) that this number is not scientifically defensible and should really be much higher.

He also notes that finer distinctions are necessary to elucidate the many different levels of "protection."

Table 5. Nova Scotia's Provincial Protected Parks and Wilderness Areas by Forest and Non-Forest Categories

	Total Forest (ha)	Non Forest (ha)	Water (ha)	Total (ha)
Wilderness Areas	211,658	60,394		291,000
Private Reserves				900
Nature Reserves				1,379
Ecological Reserves				1,200
Provincial Park Reserves				7,900
Provincial Parks*	12,704	2,672		9,700
Special Lands				5,200
Federal Parks	96,443	35,712		132,155
Total	320,806	98,778	13,619	449,343
Percentage of provincial total (5.5 million ha)	7.6%	10.1%	5.4%	8.1%

Source: NSDNR GIS Inventory Data (1999); D. MacKinnon pers. comm. (2001); K. DeGooyer pers. comm. (2001).

Note: In some cases it was not possible to determine the amount of area occupied by water or non-forest. In those cases, only total area was reported.

*Total provincial parks according to NSDNR GIS (l999) is 15,376 ha, but only those that contribute to the total area protected, as defined by the World Wildlife Fund, were used in the calculations for Table 5.

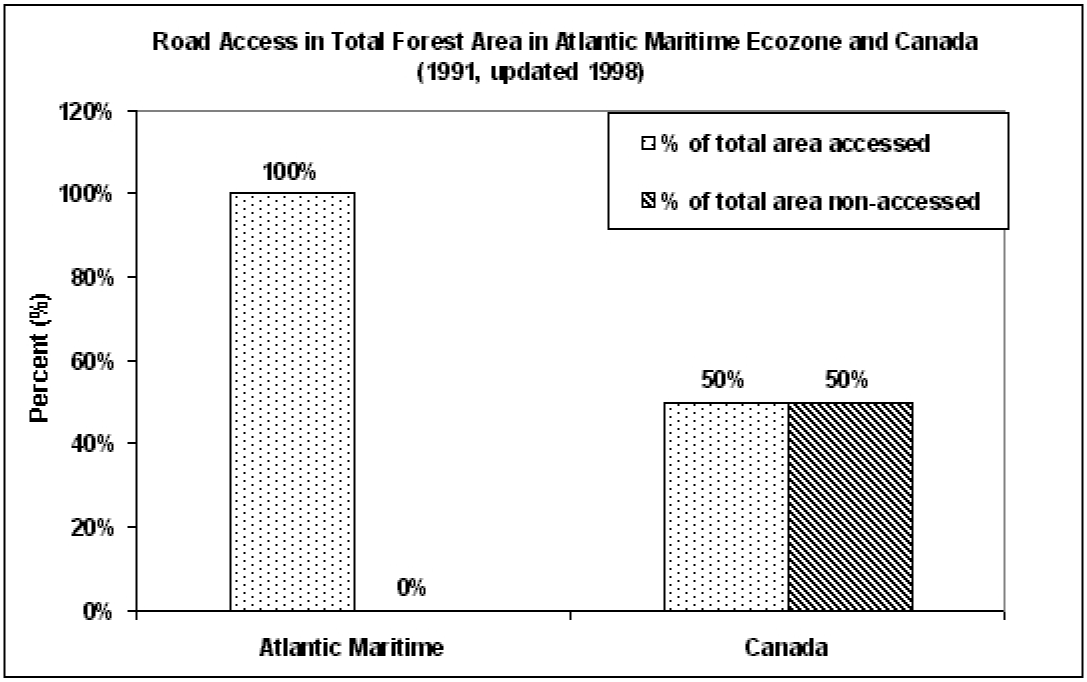
Indeed, even the very best forestry practices on private woodlots, using the most ecologically friendly harvest techniques, are no substitute for a network of protected areas in which no logging at all occurs. Such a network is the only guarantee for adequate protection of vital natural assets at the landscape level. Time and funding constraints did not permit a full exploration of the relationship among different land use patterns, including the various levels of protection required and their relation with adjoining forestry operations. GPI Atlantic acknowledges the need to develop this critical aspect of forest value and use in future updates of this report.

7.1.4 Level of fragmentation of forest ecosystem components

The Nova Scotia Department of Natural Resources does not have information regarding fragmentation and/or connectedness of forests. However, according to the National Forestry Database, the fragmentation of the province's forests can be assessed as high, and the ecological integrity is correspondingly low.

In addition, the CCFM (1997) reports a moderate road density of greater than 0.25 km/km[2] in the Atlantic Maritime ecoregion (Figure 9). The density of roads is calculated as the length of all existing roads divided by the surface area. Because the building of roads inevitably leads to human access and activity, the density of roads is a good indicator of the extent and intensity of human access and potential disturbance.

Figure 9. Road Access in Total Forest Area in Atlantic Maritime Ecozone and Canada (1991, updated 1998)



Source: Canadian Forest Service, Natural Resources Canada, Ottawa, Ontario.

7.2 Species Diversity

Natural species diversity refers to the full array of native species known to Nova Scotia at the time of European settlement, and includes consideration of distribution, abundance, age-class structure, genetic diversity, and ecological inter-relationships. It is a critical indicator of overall forest function and integrity, which in turn can determine forest quality and economic value.

A 1994 study in the journal *Nature* found that ecosystems with losses in plant and animal biological diversity showed significant losses in ecosystem performance in a number of ecosystem functions and in the provision of essential ecosystem services (Naeem et. al. 1994). In sum, natural species diversity is a vital indicator of the capacity of a forest to perform its manifold functions effectively and optimally.

In addition, there is growing evidence that conserving the natural biological diversity of regional ecosystems provides stability for these ecosystems by buffering against natural and artificial stresses, and that this diversity also maintains productivity (Smith 1996). Both factors translate into economic benefits. For example, in the Acadian forest, the loss of the natural species composition or diversity in terms of the hardwood-softwood balance has been associated with an increase in susceptibility to insect infestation, which can result in economic losses to woodlot owners and the forest industry.

The importance of maintaining the naturally diverse Acadian forest community types is also illustrated by the field study mentioned earlier that found vital linkages between different tree species functions, the activity of fungi, carbon transfer, soil quality, and timber productivity. That seminal British Columbia study found that hardwood species transfer carbon resources through underground mycorrhizal fungi to softwood seedlings that are establishing under the shade of faster-growing hardwoods, and that seedlings rich in ectomycorrhizae have the greatest net transfer of carbon, resulting in better growth (Simard et. al.1997).

In sum, there is strong evidence that maintaining a natural forest can provide significant economic benefit both by stimulating productivity and growth, and by enhancing resilience and protecting against insect infestation and other stresses. These might be termed “indirect” economic benefits. However, there are also direct economic benefits from the maintenance of natural species diversity, and a potential loss from its diminution.

A change in the natural composition of forest communities can also result in a decreased presence of high-value species and wood quality. Both factors can lower revenues received for forest products and lower the potential for value-added jobs.

In addition, a forest-dependent community that is based on a diverse forest, and therefore on a wide range of forest products, is more resilient to market price and demand fluctuations. For example, if a variety of both softwoods and hardwoods are harvested, and if local forests also support an ecotourism industry, then a drop in pulp and paper prices will be less likely to devastate a community economically, as hardwood and tourism demand prices may remain more stable. By contrast, a community totally dependent on production for the pulp and paper industry may find its fortunes more at the mercy of market forces and price fluctuations beyond its own control.

7.2.1 Number of known forest-dependent wildlife species

The dramatically changing nature of Nova Scotia's forests since European colonization, and the loss of old-growth forests in particular, has affected the habitat and abundance of many species of forest-dependent flora and fauna in the province. Today, there are only a few remaining stands of old growth forest left in Nova Scotia, and those that remain are small, isolated, and have been degraded by surrounding clearcuts and roads. Thus, as with many species and ecosystems world-wide, most if not all the virgin old growth forests in this province were eliminated before most old-growth dependent species were identified and known.

It is difficult to predict the precise effects forestry operations have had on forest wildlife in Nova Scotia, as baseline information about the vast majority of forest species is absent, and complete species lists exist for very few taxonomic groups (Kehler et. al. 1996). We do know, however, that a critical component of the habitat for many old-growth dependent animals is natural or excavated cavities that occur in large-dimension dead snags, in large living trees with heart-rotted interiors, or in logs on the forest floor. All of these habitats are substantially depleted in intensively managed, second-growth forests (Freedman et. al. 1996).

In addition, we know that forest fragmentation and edge effects caused by clearcutting and roads, can have severe impacts on species that require large territories, and/or large uninterrupted tracts of forests; that are susceptible to predation and parasitism by edge-loving species; that are sensitive to human contact; that are frequently killed on roads; or that are unlikely or unable to traverse large openings (Schonewald-Cox and Buechner 1992).

To date, very few studies have examined the biological impacts of forest fragmentation and harvesting of mature forests on wildlife in Nova Scotia. For example, no studies have examined the effects of forest fragmentation on bird populations in Nova Scotia (Staicer pers. comm. 2001a).

Given the paucity of evidence for Nova Scotia, we have to rely, for the most part, on research and studies carried out in other parts of North America. When all the available evidence indicates that a certain species is vulnerable to forest conversion and/or forest fragmentation in other parts of North America, we can only assume that the same applies to Nova Scotia. Without evidence to the contrary, the precautionary principle (adopted as law in this province) would appear to indicate that action must be taken to protect the habitat of these same species in this province:

> *"The precautionary principle will be used in decision-making so that where there are threats of serious or irreversible damage, the lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation".*
>
> Nova Scotia Environment Act, Part One, Section 2 (b) (ii)

Currently, however, most species that are sensitive to clearcutting are not considered in decisions that influence land use practices.

The following summary lists some species or groups of species that have been identified as sensitive to clearcutting, either because they are strongly associated with old growth, older or mature forests, or because they are known to be sensitive to forest fragmentation and edge effects. Many of these species perform roles and functions that are critical to forest health and timber productivity (see for example the description of the northern flying squirrel below). This list is by no means comprehensive, and should be updated in future editions of this report.

Lichens

Steven Selva, a professor of Biology and Environmental Studies at the University of Maine, has found that epiphytic lichen richness increases with stand age in Acadian regions. He found that old-growth stands harbour more species of rare lichens, and that remnant old-growth stands are "hot-spots" of lichen species diversity and thus of great conservation value.

Selva has also found strong evidence that the richness of calicioid lichens can be used as an indicator of the continuity of a stand. The rarest of calicioid lichens are mostly absent from stands that have been cut in the past. Using lichens as bio-indicators, Selva found that the most ancient forests in Nova Scotia are coniferous stands at French River and Panuke Lake and hardwood stands along the Margaree River, North River, Sugarloaf Mountain, and Trout Brook protected areas (Selva 2001).

Plants

Recent botanical research in Nova Scotia has revealed that the understory plants*, Aralia nudicaulis*, *Coptis trifolia*, *Dalibarda repens*, *Dryopteris intermedia*, *Linnaea borealis*, *Maianthemum canadense*, *Oxalis Montana*, *Trientalis borealis*, *Trillium undulatum*, *Monotropa uniflora*, *Pyrola chlorantha*, *Smilacina racemosa* and *Veronica officinalis* all have a strong association with late-successional stands 100-165 years in age. Four of these species were only found in coastal old-growth spruce forests: *D. repens*, *M. uniflora*, *S. racemosa*, and *V. officinalis* (Moola and Vasseur 2001).

In addition, Canada yew, striped maple and hobble-bush have all been noted to have strong associations with old-growth forests in the northern hardwood regions of New England (Whitney and Foster 1988; Egler 1940; Nichols 1913).

Arthropods

Numerous species of arthropods are specific to or more abundant in old-growth forests, although remarkably few studies have been made of this ecologically important, highly diverse group of organisms (Freedman 1996). A recent study of beetle communities in Nova Scotia concluded that beetle species diversity may suffer as a consequence of current forestry operations in two main ways: (1) from the conversion of hardwood or mixed wood stands to pure softwood stands, and (2) from rotation cycles too short for large diameter deadwood to accumulate and/or for species to colonize this habitat (Kehler et. al.1996).

In Sweden, old trees, logs, and snags have been identified as important habitat elements for endangered invertebrates, fungi, lichens, and bryophytes. Several hundred forest invertebrates have been red-listed in Sweden, including over 130 species of beetles (Kehler et. al. 1996). Previous research from Scandinavia and elsewhere has documented significant associations between beetles and different deadwood characteristics, as well as negative impacts resulting from forestry operations (Kehler et. al.1996).

Examination of the intact old-growth forest of the Carmanah Valley indicated that this structurally complex habitat acts as a reservoir for biological diversity. Thirty species of oribatid mites and 8 species of staphylinid beetles were new to science, and all of these species demonstrated habitat specificity to micro-habitats found within the old-growth forest. This was most apparent in the moss-mats of the high-canopy, where the oribatid mite fauna was composed of 56 species, among which 15 undescribed species were canopy specific (Winchester and Ring 1996).

Northern flying squirrels

The northern flying squirrel has been identified as a keystone species in the old growth forests of the Pacific Northwest because of its significant role in the dispersal of hypogeous mycorrhizal fungi (Maser *et. al*. 1986). These fungi form symbiotic relationships with the roots of many plant species, including commercial tree species. The plant benefits by a more efficient uptake of essential elements for growth and survival, and the fungi benefits by receiving carbohydrates from the host plant. As these fungi fruit underground, the role of the flying squirrel is to dig up the fruiting bodies, consume them as food, and disperse the spores through the forest in their scats (Fundy National Park Ecosystem Conservation Plan, 1997). In sum, this species plays a vital role in maintaining forest health and enhancing timber productivity.

Research studies conducted in the Greater Fundy Ecosystem, New Brunswick, have shown that the northern flying squirrel plays a critical role in the dispersal of hypogeous mycorrhizal fungi. Moreover, these studies have shown that the northern flying squirrel is dependent on the structural features of older forest (Gerrow 1996). Flying squirrels are arboreal animals, depending on an intact forest canopy for traversing the landscape (Carey 1996) and natural or woodpecker-created cavities for shelter (Carey 1995).

Research has also confirmed that the northern flying squirrel may have a limited ability to disperse through the fragmented forest, and that densities of flying squirrels are significantly lower in fragmented landscapes. Taulman et. al. (1998) found that squirrel densities declined following experimental logging in Arkansas; and Carey et. al. (1997) suggested that present day logging practices leave few of the old-growth characteristics suspected to be essential for the northern flying squirrel to prosper. Preliminary data collected in and around Fundy National Park also support these findings for the Greater Fundy Ecosystem (Vernes 2001; Fundy National Park Ecosystem Conservation Plan, 1997).

Southern Flying squirrels (classified as vulnerable)

While much less is known about southern flying squirrels, they are considered naturally rare in Nova Scotia, and are associated with mature and old growth forests with significant components of dead snags (Bondrup-Nielsen pers. comm. 2001; Scott pers. comm. 2001).

Moose

Nova Scotia's indigenous moose population is on the verge of disappearing, squeezed into an ever-shrinking habitat, subject to disease, and confronted by a growing lack of genetic diversity (Snaith 2001). Mainland moose now number 1,000, far below the population level of 5,000 that experts regard as necessary for long-term viability (Snaith 2001).

While clearcutting creates regeneration which provides good moose browse after 10-40 years, large cuts do not provide optimal moose habitat due to increased homogeneity, reduced interspersion of food and cover, and the reduction of critical thermal and escape cover (Snaith 2001). Studies cited by Snaith indicate that moose tend to avoid foraging in large open areas, especially during the snowy period, and generally will not move more than 80-200 metres from cover. Snaith recommends the retention of 55-70% of all management units in mature forest cover to maintain moose on the landscape.

Marten and Fisher

Both marten and fisher are widely considered to be threatened by forest harvesting and management (Forsey and Baggs 2001; NBDNR&E 2000; Potvin et. al. 2000; Robitaille and Aubry 2000; Freedman et. al. 1996; and Thompson and Colgan 1994). This is largely because of their apparent dependence on old growth, coniferous forests for at least part of their range, in part because of the structural complexity associated with coarse woody debris in those forests. Large coarse woody debris provides marten and fisher with natural dens, lanes for movement, and subnivean habitat for denning and hunting during winter (Freedman et. al. 1996).

Thompson and Colgan (1994) noted that marten experience greater survival and production rates in old growth forests than in post clearcut forests, and Robitaille and Aubry (2000) found that martens tend to avoid roads.

Lynx

Older forests are a necessary component of lynx habitat for much of the year, and particularly during the winter (Freedman pers. comm. 2001).

Trout

The optimal temperature range for adult brook trout is 11^{o}C - 16^{o}C, while temperatures warmer than 20^{o}C cause stress. At 25^{o} C, morality occurs within several hours (Brett 1956; Raleigh 1982). The high temperatures measured in six cutover streams in the vicinity of Fundy National Park, NB, were sufficient to cause physiological stress, and on three cutover streams, mortality (O'Brien 1995).

Wood turtle (classified as vulnerable)

Wood turtles use forest cover to avoid high temperatures. They are also very influenced by the hydrodynamics of watersheds, as one of the biggest threats to wood turtles is disturbance and flooding of nesting sites in gravel banks (Herman pers. comm. 2001). Changes in the hydrological regimes of rivers and brooks as a result of harvesting practices influence the viability of wood turtle nests.

Yellow-spotted and red-backed salamanders, spring peepers, and wood frogs

A study by Waldick et. al. (1999) in New Brunswick reported that amphibians were more abundant in natural forest than in plantations of any age. The most common terrestrial amphibian in natural forest was the Redback Salamander, but it occurred in only one of 33 plantations examined. The study found that conversion of natural, mixed species forest into conifer plantations was most detrimental to yellow-spotted and red-backed salamanders, spring peepers and wood frogs.

Another study indicated that Eastern newts are not able to cross extensive open areas, and are therefore considered sensitive to forest fragmentation (Gibs 1998).

Hawks

According to Freedman (pers. comm. 2001), all accipiters are sensitive to clearcutting practices. Goshawks prefer heavy old growth hardwoods and mixed woods at nesting time, and reach their highest abundances in old-growth or relatively undisturbed mature forest (Staicer 2001b; NBDNR&E 2000; Tufts 1986). In Newfoundland, Gosse and Montevecchi (2001) found that the numbers of birds-of-prey were highest and most diverse in old growth forests. The New Brunswick Department of Natural Resources and Energy has identified red-tailed hawks and broad-winged hawks as strongly associated with old forests (Beaudette 2000).

Barred owl

Barred owls require large-sized cavities in older trees for nesting. According to the Maritime Breeding Bird Atlas, there were likely more barred owls in earlier times when there were greater proportions of mature forest.

Thrushes

Bicknell's Thrush was recently listed as vulnerable. Clearcutting and pre-commercial thinning may cause adverse, short-term impacts on Bicknell's Thrush breeding habitat, but the effects of these activities are unknown (Chris Rimmer pers. comm. 2001; Yves Aubry pers. comm. 2001).

Swainson's thrush were virtually absent from the fragmented landscape in western Canada, yet were common in contiguous forest (Hobson and Bayne 2000); had become nearly absent in 20 metre riparian strips by the third year after clearcutting (Darveau *et al.* 1995); and were strongly associated with mature hemlock forests in the Rossignol District of the Bowater Paper Company in southwestern Nova Scotia.

Gray-cheeked thrush were most abundant in old forests in Newfoundland (Thompson and Montecchi 1999).

Warblers

Northern parula warblers and blackburnian warblers reached their highest abundances in old-growth or relatively undisturbed mature forest in southwestern Nova Scotia (Staicer 2001b). Blackburnians were virtually absent from the fragmented landscape in western Canada, yet were common in contiguous forest (Hobson and Bayne 2000), and were strongly associated with mature hemlock and spruce/fir forests in the Rossignol District of the Bowater Paper Company in southwestern Nova Scotia.

Tennessee, magnolia, bay-breasted and black-throated green warblers were virtually absent from the fragmented landscape in western Canada, yet were common in contiguous forest (Hobson and Bayne 2000). The latter two species were also strongly associated with mature hemlock and/or spruce/fir forests in the Rossignol District of the Bowater Paper Company. Darveau et. al. (1995) found that by the third year after clear-cutting, black-throated green warblers had become nearly absent in 20-m riparian strips

Black-throated blue warblers and golden-crowned kinglets were strongly associated with mature pine forests in the Rossignol District of the Bowater Paper Company. The latter had become nearly absent in 20-m riparian strips by the third year after clearcutting, along with the Blackpoll warbler (Darveau et. al. 1995).

Black and white warblers responded negatively to edge effects in Quebec (Morneau et. al. 1999) and were strongly associated with mature spruce/fir forests in the Rossignol District of the Bowater Paper Company.

Woodpeckers

Pileated and black-backed woodpeckers, as well as yellow-bellied sapsuckers, are strongly associated with mature forests (Staicer 2001b; NBDNR&E 2000; Setterington et. al. 2000; Thompson and Montecchi 1999; Freedman et. al. 1996).

Other birds that are either sensitive to edge effects, or reach their highest abundances in old-growth or relatively undisturbed mature forest include ovenbirds (Betts pers. comm. 2001; Staicer 2001b; NBDNR&E 2000); Eastern wood-pewee (Staicer 2001b; NBDNR&E 2000); Solitary vireo (Bowater Paper Co; NBDNR&E 2000); Red eyed vireo (Staicer 2001b; NBDNR&E 2000); White-breasted nuthatch (Staicer 2001b; NBDNR&E 2000); Scarlet tanager (Betts 1999; NBDNR&E 2000); Least flycatcher (Staicer 2001b; NBDNR&E 2000); and Brown Creeper (Hobson and Bayne 2000; Bowater Paper Co.; Staicer 2001b; NBDNR&E 2000).

In sum, the weight of evidence from a wide range of sources indicates that the loss of old forests has likely had an adverse impact on the habitat and abundance of several species of forest-dependent animals, birds, and other flora and fauna in Nova Scotia. Table 6 notes forest-dependent species classified as vulnerable, threatened, or extirpated in the Atlantic Maritime Ecozone, as listed by the Canadian Council of Forest Ministers and other sources.

Caribou are now extirpated from Nova Scotia, and their absence has been linked to various factors, including changes in forest cover.[42] There are currently four known forest-dependent birds, mammals and reptiles that have been classified as vulnerable or threatened (Table 6).

[42] Tony Duke, Manager, Wildlife Resources, NSDNR, notes that: “The demise of the caribou and wolf are linked to more than loss of old forest. Historical references to wolves are very rare and it is speculated their population was extremely small due mostly to Nova Scotia's small size. Like other island populations, their numbers 'blinked on and off' over the centuries responding to the continental population. The decline of the caribou has been linked to warming climate, arrival and increase in white-tailed deer, burning of their food and cover by early settlers and finally over-hunting” (Duke 2001a) Nevertheless, both the Canadian Council of Forest Ministers and Natural

Table 6. Known Forest-Dependent Species in the Atlantic Maritime Ecozone Classified as Threatened, Vulnerable or Extirpated

Vulnerable	Threatened	Extirpated
- Southern flying squirrel - Wood turtle - Bicknell's thrush (newly listed)	Blanding's turtle (Nova Scotia population)	Caribou Gray Wolf Eastern Cougar

Sources: CCFM 1997; State of Canada's Forests 1998-1999; Wild Species 2000 (COSEWIC); Herman 2001; Bondrup-Nielsen 2001; Scott. F. 2001.

However, this list is clearly not complete. As noted above, for example, wildlife experts have warned that Nova Scotia's indigenous moose population is on the verge of disappearing, with an ever-shrinking habitat and with numbers just one-fifth the population level of 5,000 that experts regard as necessary for long-term viability (Snaith 2001; Delaney 2001).

The Canadian Council of Forest Ministers and Montreal Process indicators also include animal population trends for selected species of economic importance, and the availability of habitat for selected wildlife species of economic importance. Both indicators can be included in future updates of this report.

7.2.2 Population levels and changes over time for selected tree species

Changes in Species Composition of Nova Scotia's Forests using DNR Forest Inventory

a) Inventory methodologies

The first complete forest inventory based on large-scale photographs and forest type maps was completed in 1957, with results reported in a 1958 document entitled *The Forest Resources of Nova Scotia* (Hawboldt and Bulmer 1958). Between 1965 and 1971, the province began a continuous forest inventory program. Random temporary sample plots across the province were measured each year. In 1980, the inventory methodology changed to a multi-stage process called the 3P program. Point sampling, which uses a variable plot size based on tree diameter, metric units, and aerial photography became operational. 3P statistical information was published in a series of reports, two of which are used in the following analysis (NSDNR 1999).

Photo interpretation of each forest stand in the province began in 1987. The resulting data have been stored in a Geographic Information System (GIS) database. GIS is a spatially-based information system for geographic and biological information. Portions of the database have been updated since 1996, but it is still referred to as the 1995 inventory. One limitation of this

Resources Canada do list both the caribou and gray wolf as extirpated "forest-dependent" species, and so they are noted in evidence for this particular indicator.

inventory method is that only four major categories of species can be identified for use in the GIS system, while the other species are compiled together, so that detailed species analysis is not always possible (NSDNR 1999).

The Department of Natural Resources (NSDNR) also maintains a permanent sampling system (PSP) designed to monitor volume growth, mortality, and biodiversity. The PSPs were established in 1965 and are re-measured every five years. Analysis of the PSP data has just been published in two NSDNR reports (NSDNR 2000a, NSDNR 2000b).[43]

b) Softwood species

Figure 10 shows the proportion of softwood tree species as a percentage of the total gross merchantable volume for several inventory stages from 1958 to 1995. Red and black spruce are presently the dominant species in the province, but because it is difficult to differentiate between the two species, their volume is combined in the DNR database. According to the most recent forest inventory, red and black spruce have dramatically increased in proportion to the gross merchantable provincial forest volume from 22.7% in 1958 to 35.3% in 1995. In absolute volume, red and black spruce have increased from 75 million cubic metres (m^3) to 136 million m^3, an 81.3% increase in volume.

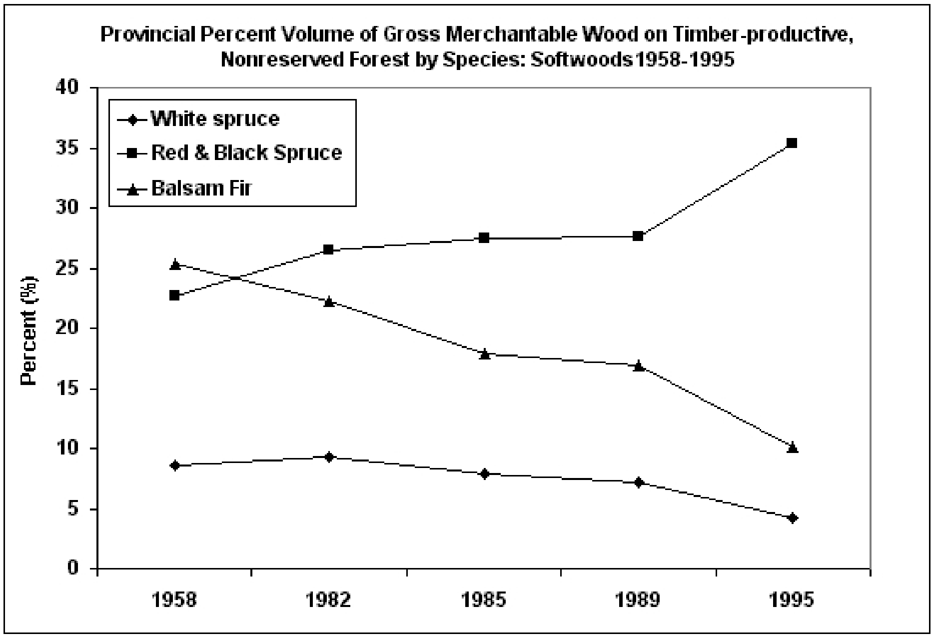
Forest inventories show a parallel decline in the percentage of gross merchantable volume of white spruce (8.6% to 4.2%) and balsam fir (25.3% to 10.1%), according to the inventories carried out by the DNR between 1958 and 1995. Balsam fir volume decreased dramatically between 1958 and 1985, as a result of losses due to spruce budworm infestations (NSDNR 1994).

As noted below, however, inventory reports of a particularly sharp increase in spruce and decline in balsam fir in the last 10 years alone are suspect, and may be due to changes in inventory methodology rather than actual changes.

White pine was the most important timber tree in parts of Nova Scotia during the 18th and 19th centuries (Johnson 1986). Johnson (1986) reports that most of the province's red pine was cut before 1960, and by 1986 comprised only 0.3 percent of the total provincial volume. Since then, white pine has increased in volume from 13.3 million m^3 to 16.8 million m^3, and red pine has declined further from 934,000 m^3 to 556,000 m^3 (Figure 11). Thus, while the volume of white pine has increased recently after a long historical decline, red pine volume has continued to decrease. Despite the recent volume increase, white pine remains stable at about 4% of gross merchantable volume.

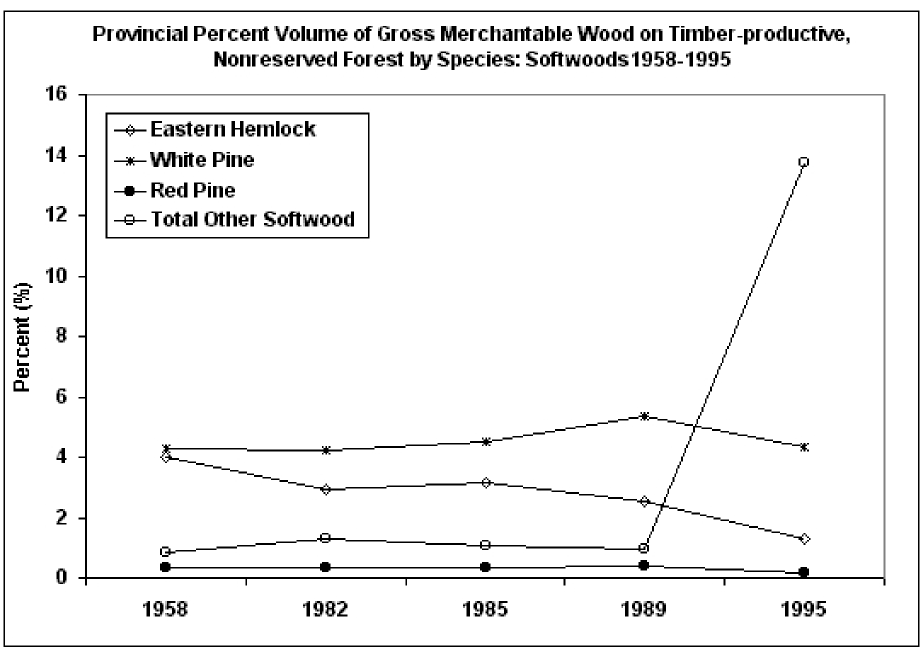
[43] See Section 6.3 above on limitations in the use of PSP data in assessing stock volume, and species and age class distribution for the province as a whole.

Figure 10. Provincial Percent Volume of Gross Merchantable Wood on Timber-Productive Nonreserved Forest by Species: Softwoods (White Spruce, Red & Black Spruce and Balsam Fir) 1958-1995



Source: Nova Scotia Forest Inventory Provincial Summary 1975-1982, 1976-1985, 1979-1989; and DNR GIS February 1999 Inventory Data.

Figure 11. Provincial Percent Volume of Gross Merchantable Wood on Timber-Productive Nonreserved Forest by Species: Softwoods (Eastern Hemlock, White Pine, Red Pine and Other Softwoods) 1958-1995



Source: Nova Scotia Forest Inventory Provincial Summary 1975-1982, 1976-1985, 1979-1989; and DNR GIS February 1999 Inventory Data.

Three hundred year-old stands of almost pure eastern hemlock were common in several parts of mainland Nova Scotia in the early 1900s. Since 1958, eastern hemlock has decreased sharply from 13.2 million m^3 to 6.3 million m^3 (4.0% and 1.3 % of total volume, respectively; Figure 11).

Some of the recent trends that appear in Figures 10 and 11 may well be an artefact of changes in the inventory methodologies. Figure 10 shows balsam fir and white spruce continuing to decrease over the past decade (1989 to 1995) following the spruce budworm infestation of the 1980s, while red and black spruce have dramatically increased in the same period. The sudden increases in volume shown in the chart may be the result of the change in inventory techniques, since only the latest inventory is GIS-based. No other accurate explanation has been found for such a large change in volume over just 10 years.

Similarly, Figure 11 shows the percentage of forest classified as "total other softwood" increasing steeply over the last decade. Proportionally, "total other softwood" has increased from 0.8% to 13.7% of the total volume, and in absolute volume the category has risen from 2.4 million m^3 in 1989 to 52.7 million m^3 in 1995, a huge increase of 50.3 million m^3. This may be the result of a greater number of species being combined in this category in the new GIS inventory system. Given the vital importance of natural species diversity and forest composition as an indicator of forest quality, health, and productivity, it is clear that the absence of reliable and unambiguous long-term trend data is a major shortcoming.[44]

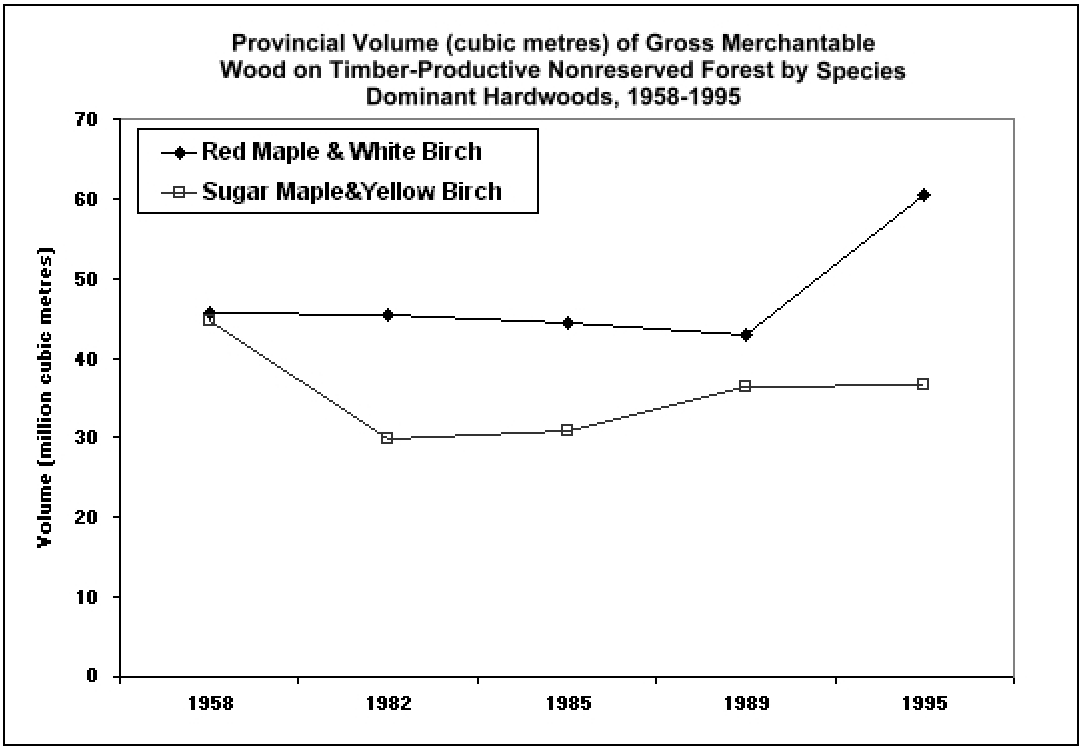
c) Hardwood Species

The volume of red maple and white birch (shade-intolerant hardwoods) has sharply increased in volume in recent years, whereas yellow birch and sugar maple volumes (shade-tolerant hardwoods) have declined from 1958 volumes (Figure 12). As a percentage of gross merchantable wood, the volume of Nova Scotia's red maple and white birch increased slightly since 1958, from 13.8% to 15.7% in the most recent inventory. However, the absolute volume of red maple and white birch only dramatically increased between the last two forest inventories (1989 and 1995), from 48.2 million cubic metres in 1989 to 60.4 million cubic metres at the present time.[45]

[44] Ken Snow, Manager, Forest Inventory, NSDNR (2001) notes that the Department's permanent sampling plot data give a more detailed species list than that in the 1995 GIS forest inventory. In accordance with Mr. Snow's suggestion, the PSP species data should certainly be accessed in future updates of this report to provide a more detailed breakdown of species in some of the categories that have been combined in the GIS inventory. For province-wide estimates, the forest inventory data was used in this report in preference to the PSP data for the reasons explained in Section 6.3 above, particularly in light of the substantial differences between the PSP data and (a) the forest inventory data, and (b) the historical evidence.

[45] NSDNR staff attribute this and other dramatic changes in species volume in the last 10 years, as reported in the Department's own forest inventories, to a change in inventory methodology rather than to actual changes of the magnitude indicated (MacQuarrie 2001). In the absence of any published data by the NSDNR reconciling these distortions with other available data, GPI Atlantic has no choice but to report the results from NSDNR inventories. As the NSDNR itself uses these inventories for its wood supply projections, explanations concerning the impact of the inventory methodologies on reported results would appear to be useful to the Department as well as to independent researchers.

Figure 12. Provincial Volume of Gross Merchantable Wood on Timber-Productive Nonreserved Forest by Species: Dominant Hardwoods (Red Maple & White Birch and Sugar Maple & Yellow Birch) 1958-1995



Source: Nova Scotia Forest Inventory Provincial Summary 1975-1982, 1976-1985, 1979-1989; and DNR GIS February 1999 Inventory Data.

d) Hardwoods: Shade-tolerant trees

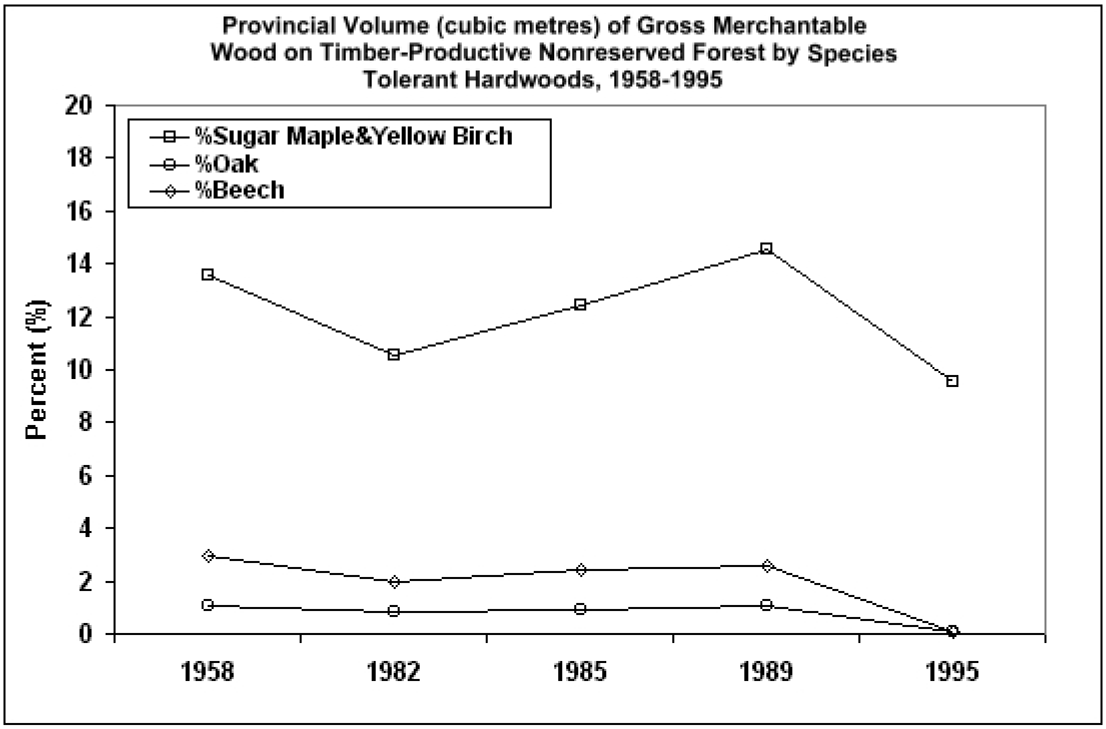
Forest inventory data indicate a particularly sharp decline in the province's merchantable beech and oak over the past ten years. Between 1958 and 1995, merchantable beech volume declined by 98%, from 9.9 million cubic metres to just 0.2 million cubic metres. As a proportion of gross merchantable wood in the province, this represents a decrease from 3.0% to 0.05% of total volume (Figure 13).[46]

Merchantable oak volume declined by 89% from 3.5 million cubic metres in 1958 to 0.4 million cubic metres in the latest inventory, with almost the entire loss occurring in the past 10 years. As a percentage of total provincial forest volume, this represents a decline from 1.1% to just 0.1%. Since almost the entire change in beech and oak volumes is recorded as occurring in the last 10

[46] Beech bark disease, caused by the introduced beech scale insect and *Nectria coccinea* fungus, is responsible for much of the recent decline in beech volume throughout North America (Farrar, 1995; and Ontario Ministry of Natural Resources. 1998).

years, it has been suggested that the reported decline may be an artefact of changes in inventory methodology.[47]

Figure 13. Provincial Volume of Gross Merchantable Wood on Timber-Productive Nonreserved Forest by Species: Tolerant Hardwoods (Sugar Maple & Yellow Birch, Oak and Beech) 1958-1995



Source: Nova Scotia Forest Inventory Provincial Summary 1975-1982, 1976-1985, 1979-1989; and DNR GIS February 1999 Inventory Data.

Although Figures 12 and 13 combine sugar maple and yellow birch, in accord with the 1995 GIS inventory, inventories up to 1989 gave separate estimates for each species. Sugar maple increased in absolute volume between 1958 and 1989, and in 1989 accounted for 8.9% of the total merchantable timber volume. In 1989, yellow birch accounted for 5.7% of merchantable volume. The latest forest inventory provides only aggregated data for yellow birch and sugar

[47] Despite the fact that these numbers come from the NSDNR's own inventories, some DNR staff question their accuracy, and attribute the change to new inventory methodologies rather than to actual declines (MacQuarrie 2001). However, these publicly available inventory data are used by the NSDNR itself to determine the potential wood supply for the province and the annual allowable cut on Crown lands, assessments that should certainly account for changes in species composition. GPI Atlantic therefore urges the department to reconcile inventory data that it considers misleading with other evidence at its disposal, and to publish explanations for these discrepancies. In the meantime, GPI Atlantic has to rely on the NSDNR forest inventory data for its results in this section. Ken Snow, Manager, Forest Inventory, NSDNR, notes that PSP data report beech at 4.2 million m^3 and oak at 3 million m^3 (2001.) While the very low numbers reported in the GIS data may well be the product of the inventory methodology, the evidence in Section 6.3 above indicates that the PSP data may yield highly exaggerated results when extrapolated for the province as a whole. The reality may lie in between these two very different sets of results.

maple and shows a 34% decline for these two species in their proportion of total merchantable timber volume, from 14.6% of merchantable timber in 1989 to just 9.6% in 1995.

The rapidly declining proportion of shade-tolerant hardwoods, including the very sharp recent decline of two key species, demonstrates the increasing dominance of the softwood industry in the province and the consequent decline in natural species diversity. For shade-tolerant hardwoods, the most dramatic changes in proportion have occurred in the last 10 years. As noted earlier, changes in provincial inventory systems and classification categories may be distorting the trends described here. Because natural species diversity is such a key indicator of forest health and productivity, there is clearly a necessity for better physical accounts of changes in species composition in order to track these trends more reliably.

e) Estimating the Economic Impacts of Changes in Species and Age Composition

GPI Atlantic recommends that future updates of this report match changes in species composition with changes over time in the market price of different species. This will allow researchers to assess the direct and immediate economic impact of these trends and to determine whether changes in species composition have produced an increase or loss in the direct market value of the province's merchantable timber. By comparison with the species that are dominant today, what, for example is the market value of white pine, red pine, white spruce, eastern hemlock, aspen, yellow birch, oak, beech, and other species that were once more dominant than they are today?

Such market-value assessments have been done in this study for clear versus knotty wood, and for lumber of different diameters[48], but time and resources did not permit a similar analysis by species. Such analyses will make it possible to determine the direct economic impact of changes in both the representation of old-growth communities and natural Acadian forest species diversity over time.

For example, historical records indicate that white pine was the most important timber tree in parts of Nova Scotia during the 18th and 19th centuries, with much of it high-graded for masts and squared timber during the 1800's. By assessing the potential value of white pine and other species today, particularly for clear lumber with a wide-diameter girth, the long-term economic benefits of restorative forestry investments can be estimated.

Conversely, by assessing changes in species abundance alongside the market value of each species, measures of forest value depreciation over time can also be estimated. Those assessments, in turn, can help provide estimates of the total investment necessary to return the forest to its most valuable and productive state. They can also provide policy makers with monetary estimates of the incentives necessary to encourage restorative forestry practices. Some preliminary estimates of these restoration costs and investments appear in Volume 2 of these accounts.

[48] See Volume 2, Chapter 8 of these accounts.

Funding and time limitations did not permit the authors to make all these assessments for the current study, but they are strongly recommended as a direction for future research. Ideally such assessments will include not only direct market impacts of changes in age and species composition, but also the indirect economic impacts of biodiversity trends due to changes in forest resilience and productivity. Such economic assessments have direct policy implications, including silvicultural and harvesting choices, and the structure of future silviculture credits and financial incentives that can encourage woodlot owners to make restorative forestry investments that will yield long-term benefits to Nova Scotia.

7.2.3 Number of known forest-dependent species that occupy only a small portion of their former range

One of the CCFM (1997) indicators of forest health and sustainable management is an assessment of the number of species that today occupy only a small portion of their former range. "Small portion" is defined in the CCFM indicators as a reduction in range of at least 50% of a species' historical range. In the Atlantic Maritime Ecozone three animal and four plant species have been reduced to less than 50% of their original range. These include four major tree species, white pine, red pine, red spruce, and eastern hemlock, all of which were once more dominant in the province (Table 7).

Table 7 shows Atlantic Maritime forest species (plants, animals, and birds) that are now classified as occupying less than 50% of their former range, or that are listed as extirpated, at risk, sensitive, or maybe at risk. This table, too, is not complete. As noted above, Nova Scotia's indigenous moose population, not mentioned in the list, is on the verge of disappearance, squeezed into an ever-shrinking habitat (Delaney 2001).

Although red spruce has recently increased in volume in Nova Scotia, its range is still less than 50% of its historical range in this region:

> *"Red spruce has historically been an important and characteristic component of the Acadian Forest Region of Eastern Canada. However, red spruce has declined to a point where it is becoming increasingly uncommon across large portions of its former range. Current site occupancy of red spruce has been estimated at between one tenth and one fifth of its former extent in terms of population sizes, numbers and geographic distribution. Red spruce has a highly fragmented distribution across most of its range"* (Mosseler et. al. 2000).

The data in Table 7 are from the Canadian Council of Forest Ministers 1997 report on *Criteria and Indicators of Sustainable Forest Management in Canada* (CCFM 1997). The most recent CCFM 2000 report again lists red spruce, white pine, red pine, and eastern hemlock as occupying a small portion of its former range in the Atlantic Maritime Ecozone. According to the CCFM (2000) report, these species have been "affected primarily by habitat loss, either through clearing of forest lands for agriculture and settlement or by reductions in the amount of forests in the older age classes." The latest CCFM report (2000) also lists fisher, lynx, marten, barred owl, black-backed woodpecker, and three-toed woodpecker as forest dependent species that occupy a small portion of their former range.

As noted earlier, eastern hemlock and red pine have continued, in more recent times, to decline in volume as well as in range (down to 1.3% and 0.3% of gross merchantable volume), while once abundant white pine today represents only 4% of total volume.

Table 7. Atlantic Maritime Forest Species Occupying Less than 50% of their Former Range, and Species that are Classified as Extirpated, At Risk, Sensitive, and May be at Risk

Species	Extirpated	At Risk	May be at Risk	Sensitive	Less than 50% of former range
Bicknell's thrush				X	
Marten			X		
Purple Martin*				X	
Barred owl					X
Long-eared owl				X	
Southern flying squirrel				X	
Eastern Cougar**	X				
Lynx		X			
Gray Wolf	X				
Caribou	X				
American Marten			X		
Fisher				X	
Atlantic Salmon			X		
Brook Trout				X	
Blanding's Turtle		X			
Plants					
White pine					X
Red pine					X
Red spruce					X
Eastern hemlock					X
Yellow lady's slipper				X	

Notes: * Uses snags or dead trees on forest floor as nesting habitat (Freedman et al. 1994)

** Undetermined status.

Sources: CCFM 1997; Wild Species 2000 (COSEWIC): www.wildspecies.ca; Scott F. 2001; Herman T. 2001; Korstian C. 1937; Gordon, A. 1996; Mosseler et. al. 2000; Busby D. 2001.

7.3 Genetic Diversity

Species diversity is highly correlated with genetic diversity. For example those forest dependent species with substantial reductions in their former range or low populations run the risk of a reduced gene pool. The loss in genetic traits due to reduced range and/or population levels translates into a decrease in a species' ability to adapt to environmental change. Losses in genetic diversity may be irreversible.

Genetic diversity is important for species' evolution, adaptation to change, and the resilience of forest ecosystems. Monitoring population levels of indicator species is required to assess both the availability of habitats and their capacity to support the integrity and viability of their respective populations. Such monitoring is particularly important for indicator species dependent on red spruce and other common tree species that have their northern limits in the Atlantic Maritime Ecozone.

A long historical legacy of high-grading in Nova Scotia forests has been particularly deleterious to the maintenance of genetic traits. The loss of the healthiest, strongest, most vigorous trees in a species may permanently degrade the genetic pool. Volume 2, Chapter 8, Section 2 of these accounts cites building contractors who report serious declines in the quality of available wood. While connections between these anecdotal observations and changes in genetic traits over time are not possible to confirm scientifically, prudence suggests that the maintenance of genetic diversity be given the highest priority in forest management practices.

7.3.1 Implementation of an in situ/ex situ genetic conservation strategy for commercial and endangered forest vegetation species

The Canadian Forest Service (CFS) does store seeds for the Maritime region. However, a full assessment and evaluation of existing genetic conservation strategies is not included in this report and should be part of future updates of these accounts.

8. Impact of Disturbance and Stress on Forest Ecosystem Health and Productivity

8.1 Incidence of Disturbance and Stress

The level of disturbance and stress on forest ecosystems provides a picture of the health and the sustainability of ecosystems for future generations. Disturbance is not always a negative force. The occurrence of natural disturbance plays a key role in the continuity of forest ecosystems. However, human-induced stress, including pollution and over-cutting, negatively affects the integrity of forest ecosystems. Natural and human-induced disturbance and stress should be monitored for the assessment of forest ecosystem function, condition and productivity.

8.1.1 Annual removal of wood products compared to the volume determined sustainable

The annual removal of wood products is a key indicator in the Montreal Process, and is the basis of most timber accounts that have been constructed to date.[49] The "volume determined sustainable" is dependent on both natural growth rates and silviculture inputs. It should be noted that these quantitative *volume* data are not meaningful in isolation from the qualitative analysis presented in the previous chapter. For this reason, the assessment in this chapter *follows* the description of changes in the natural distribution and composition of age and natural species diversity, unlike most timber accounts to date that consider quantitative volume data in isolation from changes in species and age composition and other qualitative data.

a) Challenges to AAC methods and assumptions

The most common measure of sustainable yield is the annual allowable cut (AAC). Until fairly recently, the provincial Department of Natural Resources (NSDNR) set an AAC for the province. Today, it sets an AAC for Crown lands only, while determining the potential wood supply (PWS) for the province as a whole. Sometimes this potential wood supply is referred to as the 'sustainable harvest level,' but there are still some sources that refer to it as the AAC.

The NSDNR no longer sets an annual allowable cut for the whole province because it cannot control the harvest on private lands, and therefore cannot set an 'allowable' limit. While this may appear to be an issue of semantics, the NSDNR is now quite insistent that the term AAC no longer be used. Therefore, we will use the term 'potential wood supply' (PWS) in lieu of AAC.

The setting of the PWS and the simulated models used to determine the sustainable yield, are controversial because they depend on certain key assumptions that have been widely challenged.

The following excerpt illustrates one of the concerns regarding the potential impact of assessing today's "sustainable" cut based on future actions that may or may not occur:

> *"...The AAC calculations have an explicit dependence on what is known as the AAC effect. Dr. Bailey's passive scenario demonstrates that without any silviculture, we are overcutting the forest by 40% now*[50]*. Yet if we increase our silviculture levels now and promise to maintain these high silviculture levels forever, we can actually increase our cut now.*
>
> *"Davis and Johnson*[51] *divide actions leading to an increase in annual allowable cut into two classes. Class I actions (such as reforestation) are implemented in the current year or are funded in short- term approved budgets. Class II actions (such*

[49] E. Gunn, (2001) points out that removal refers not only to harvest, but also to fire, insect and disease. In this report, Section 8.1.1 refers to harvest removals; and 8.1.2 to insect, disease, and fire removals.
[50] Based on 1992 harvest levels.
[51] Davis and Johnson. 1987. *Forest Management*. McGraw Hill.

as pre-commercial thinning) are those planned or assumed to take place in the future.…

"Class II actions, which are the majority, are innately suspect.... Implementation is just starting and little or no money is in hand to guarantee that they will be implemented. Counting on class II actions to occur is an act of faith and responsible planners should at least look hard at the likelihood that the owner will carry through."[52]

The second key question to consider is whether we are maintaining forest ecosystem health and site productivity by converting natural forests into low-value, even-aged, early successional stands, or to intensively managed conifer stands or conifer plantations.[53] . In short, qualitative distinctions apply to silvicultural practices too. It is not just a matter of "silviculture levels," but of the *type* of silviculture that is practised, and whether particular silviculture practices enhance or degrade the full range of forest values. There are both highly mechanized silvicultural techniques and highly skilled manual techniques. There are methods that maintain natural species diversity and appropriate age structures, and methods that introduce exotic species and turn old-growth forests into monocultural plantations.

The third question that is not generally considered in AAC or PWS determinations follows the second: What is the impact of the annual timber cut levels on the capacity of forests to maintain ecosystem functions and the provision of vital ecosystem services? Current wood supply models used for determining annual allowable cuts focus primarily on timber volumes to the exclusion of the wider range of forest functions described in these accounts. A fourth and related question is whether the AAC and "sustainable" cut levels consider and maintain the forests for non-timber uses such as recreation and ecotourism?

A fifth issue has to do with the lack of past historical perspective in setting AAC or PWS levels. The AAC and PWS are used to assess "sustainable" levels based on *current* stocks and *future* projections, without reference to *past* conditions and stock levels. A hidden assumption in the AAC and PWS, therefore, is that current forest stocks are a legitimate base for future projections. If our forests are *already* degraded from more than 300 years of land-clearing, high-grading, and clearcutting, then it is questionable whether the projected harvest levels are truly "sustainable" by any strict definition of that term.

Truly "sustainable" forest management may require restoration forestry techniques, including removal of the poorest quality wood, *and,* in some cases, a temporary abstinence from any

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52 E. Gunn, TUNS. Written Submission. *Developing Strategic Direction for Nova Scotia's Forest Sector.* Coalition of Nova Scotia Forest Interests and The Canadian Institute of Forestry - Nova Scotia Section. October 23-25. 1994, Amherst, Nova Scotia. Eldon Gunn points out that his main concern in the quoted statement is that there was at that time no control mechanism to ensure that required silviculture be done. However he feels that the new Forest Sustainability Regulations address the concern he had in 1994 when he made that statement (Gunn 2001).

53 On average about 15% of all harvested areas in Nova Scotia are regenerated by planting, and about 80% of planted species used are trees native to Nova Scotia (J. Beyeler 2001.). Mr Beyeler also points out plantations need not be single-species. He notes that "by establishing plantations in the Cape Breton highlands it is an attempt to increase the diversity of species so that Balsam fir does not make up such a high component and thus reduce the future susceptibilty to Budworm attacks."

cutting at all.[54] By analogy, use of a depleted fish stock as the norm from which to set future catch quotas will not produce sustainable catch levels. Rather, a moratorium may be required to restore the stock to former levels. Therefore, the current use of the AAC or PWS as a "sustainable harvest level" is questionable, when sustainability is assessed in relation to the natural historical Acadian forest and in relation to the *potential* value of the forest when restored to a semblance of its former quality.

In short, AAC or PWS levels are generally determined primarily in relation to timber supply, and in isolation from other forest functions, and are based on hidden assumptions about past and present conditions and anticipated future actions that have been challenged.

Despite these and other critical questions surrounding "sustainable yield" determinations, AAC and PWS levels, and wood supply models, provinces across Canada currently base their annual cut estimates on these assessments. In Nova Scotia, it has been particularly difficult to determine an appropriate AAC or PWS, or to regulate, monitor, and assess the annual volume cut and silvicultural treatments applied, because of the large proportion of privately-owned lands in the province. In fact, a report by the National Round Table on the Environment and the Economy noted that poor and uncoordinated record-keeping rendered current harvesting statistics highly inaccurate, and that actual harvesting levels likely exceeded official estimates (NRTEE 1997).

The best estimates that do exist show that the annual cut on private woodlots in the province has been increasing rapidly, especially over the past 10 years, while silvicultural inputs have declined. As a result of these trends, and in response to the lack of reliable data hitherto available, the NSDNR has now introduced Forest Sustainability Regulations that require silviculture to be carried out based on actual volumes harvested from private lands. A newly-created Registry of Buyers will keep track of the volumes of wood bought by individual sawmills or pulpmills from private wood lots.

The Registry of Buyers should certainly allow for more precise estimates of actual harvest levels than have been available to date. The new silviculture credits have the potential to support more sustainable forest management, and this potential will be enhanced if the five-year review of credits creates greater financial incentives for restoration forestry practices. The credits do, for the first time, recognize and reward selection harvest methods at a level at least equal to conventional methods.[55]

So far only one woodlot owner in Nova Scotia has availed himself of the selection harvest silviculture credits, and it is too early to tell whether the new regulations will create a real shift in forest practices and management in the province. As noted, the new silviculture credit system at least (and for the first time) does not discriminate against selection harvest methods, unlike earlier silviculture supports that rewarded clearcutting followed by planting, and provided no support for selection harvesting.[56]

[54] See Volume 2, Chapter 1 for a description of restoration forestry methods and costs.
[55] See Volume 2, Chapter 10, for a more detailed explanation of the new silviculture credit system as it applies to selection harvesting.
[56] The new Regulations provide for a Silviculture Credit of $250/ha for selection harvest management, eligible to be claimed every 10 years on the same site (Jorg Beyeler 2001.) Over an average 60-year rotation, even-aged

For restoration forestry to become the norm, however, other measures are necessary, including political will, education, promotion, scientific research, and structural changes in Nova Scotia's forest economy, such as a greater emphasis on value-added manufacturing. In addition, financial incentives would be commensurate with actual restoration costs, to encourage landowners to practice selection harvesting and other sustainable management methods designed to restore the full value of the province's forests.

According to Eldon Gunn, Department of Industrial Engineering, Dalhousie University, "it is tough to develop good models of situations such as growth under uneven-age management when it hasn't been practised and no data exists" (Gunn 2001). Hopefully the case studies in Volume 2 of these accounts will help provide such models of uneven-aged management, while the expressed interest of many woodlot owners in practising low-impact forestry may encourage further exploration into alternative models.[57]

It is also unlikely that there will be incentives for "best forest management practices" that could provide a real alternative to the current AAC-silviculture approach, if the official NSDNR position remains that "clearcutting is a legitimate harvest technique" and that "we neither promote nor regulate the choice of harvest location, timing, method or area" (Fage 2000). In a nutshell, a genuine alternative to past practices requires consideration of qualitative as well as quantitative data on forest health and sustainable timber use, and the political will to restore Nova Scotia's natural wealth to its potential value.

b) The Nova Scotia PWS and its Limitations

Nova Scotia's most recent annual allowable cut (now termed potential wood supply) is derived from a simulated wood supply model called Strategic Analysis of Wood Supply (SAWS) that provides projections of five-year periodic harvest levels and the silvicultural inputs necessary to attain them. Three different growth models are used in SAWS: a) first rotation unmanaged stands; b) second rotation unmanaged stands; and, c) managed stands.

The current sustainable yield (i.e. PWS) in Nova Scotia, based on a continuation of 1996 levels of silviculture activity is estimated to be 6.7 million cubic metres total for softwood and hardwood species for all ownership categories (NSDNR pers. comm.).

management allows a total of 1850 credits/ha compared to 1500 credits/ha for a selection managed area over the same 60-year period. Therefore, says Mr. Beyeler, "the acceptance and promotion of both even-aged and uneven-aged forest management systems exist on the Forest Sustainabilty Regulations." The new regulations require $3.00 of silviculture per cubic metre of softwood ($0.60/m^3 of hardwood) harvested in Nova Scotia. For a more detailed analysis of the application of the new regulations to selection harvest management, see Volume 2, Chapter 10.

[57] For example, Eldon Gunn notes that the US Forest Service has adopted the NE-TWIGS wood supply model that is an individual tree growth model capable of simulating uneven age management. He says: "I do think that it will eventually be worth our while to try to build a NE-TWIGS version for NS but it is will not be trivial to do so" (Gunn. 2001). Mr. Gunn points out that this individual tree model does not have reliable data for trees under 4 inches. Given the dramatic trend towards younger age classes and the harvesting of ever smaller diameter trees in Nova Scotia, it is difficult to see how this model can be applied in the province.

However, there are some major problems with the SAWS model. It is not designed to calculate volumes under an uneven-aged system. Because 95% of all existing management is even-aged, NSDNR notes that it currently has to use existing data sources like the SAWS model for its analyses. However, studies are now under way to determine growth rates and potential volumes for uneven-aged systems "for when they become a more significant component of management in Nova Scotia" (J. Beyeler 2001)

The SAWS model does not account for cover type changes after forest stands are harvested. It also assumes that 92.2% of small private land is available for harvesting.[58] And it assumes that harvesting and other silvicultural treatments will not have negative impacts on the productive capacity of harvested sites. These flaws and assumptions may affect assessments of sustainability in timber supply and forest management. For example, as noted earlier, vital linkages have been found between different tree species functions, the activity of fungi, carbon transfer, soil quality, and timber productivity (Simard et. al. 1997), indicating that harvest techniques may indeed have long-term impacts on site productivity.[59]

Both the forest inventory and the PSP (permanent sample plots) data, referred to in Section 7.2.2, are used to represent first rotation unmanaged and managed forest stands in the province's simulation model to calculate the PWS. In 1982, the annual allowable cut for Nova Scotia was 2.4 million cubic metres without silvicultural treatments. In 1992 the AAC was 5.3 million cubic metres, and the latest AAC (now called PWS) based on wood supply is 6.7 million cubic metres. The mean harvest between1995 and 1998 was 5.4 million cubic metres.

The latest NSDNR wood supply forecast for Nova Scotia (1996-2070) indicates that 62% of the province's forests are operable (2.6 million hectares). Deductions include: federal lands, parks and protected areas, non-participating small land-owners (7.8%), wildlife habitat and biodiversity clumps, right of ways, inaccessible areas, non/low productive lands (Land Capability <3), and non-forestry land (e.g. Christmas trees) (NSDNR presentation pers. comm. 1999). The following data and assumptions have been used in this latest wood supply analysis using SAWS:

- Natural regeneration: 66% stocking
- Plantations: 80% stocking
- Non-participation of small land-owners: 7.8%
- Cull & Waste deductions: 3% to 10%
- Insect and disease deductions: 5%
- Wildlife Habitat Clumps: 1%
- Harvest eligibility standards: 15 to 18 cm diameter limits, 9 cm top diameter, and >20% stocked

[58] E. Gunn. (2001) notes that a 7.8% non-participation assumption is very conservative "since history suggests that a very large proportion of all land is eventually harvested." Using "a simple probability model where there is a certain probability of non-participation in a given 5 year period and the results from one five year period are independent from one period to the next," he notes that there will likely be 100% participation over a 100 year period.
[59] As noted by Jorg Beyeler (2001), there are also long-term non-harvest impacts on site productivity, such as climate change and acid rain, which need to be incorporated into future wood supply projections.

The NSDNR concludes from the latest model that present harvest levels are not sustainable for small private woodlots in accordance with the 1996 levels of silviculture inputs.

The Department has therefore implemented new regulations that require wood buyers to carry out silviculture activities in order to earn credits. These new regulations should result in an increase in silviculture activity to at least double the 1996 levels. That in turn is intended to raise the sustainable harvest level to 7.65 million cubic metres for the province from all tenures, with a projected sustainable yield of 4.5 million cubic metres on small privately-owned land. Eventually, the Department projects, the annual cut will be double that in 1996. Under the scenario presented, the softwood net merchantable volume is projected to reach over 11 million cubic metres in 2070, up from approximately 5.5 million cubic metres in 1996 (NSDNR presentation pers. comm. 1999).

According to Jorg Beyeler of the NSDNR, "the primary goal of the Regulations is to make the current harvest on small private woodlots for softwood sustainable by requiring enough silviculture to achieve that" (Beyeler 2001) The evidence in these forest accounts raise questions about whether harvest levels that are already excessive, and projected to almost double, can be made sustainable just by increasing silviculture inputs.

These questions are based on two fundamental premises:

1) The definition of "sustainability" includes qualitative as well as quantitative criteria. From a strictly quantitative viewpoint and over a relatively short time horizon, increasing silviculture requirements can certainly increase the growth rate of trees. But if harvest methods undermine soil quality; age, genetic and natural species diversity; resilience to insects and disease; and other qualitative dimensions of forest health, then adverse impacts on site and timber productivity can threaten the reliability of long-term harvest projections. Qualitative assessments would also take into account not only volume projections, but the quality and value of the timber produced on a unit basis.[60]

[60] GPI Atlantic is not implying that these relationships are definitively known in Nova Scotia, or have been sufficiently studied here. But there is a growing body of scientific evidence linking qualitative factors like species diversity; soil quality, and canopy closure to long-term timber productivity and quality. Simard et. al. 1997 (cited above) have linked species diversity and soil quality to softwood productivity and growth rates. The evidence in Chapter 7 above assesses available evidence on qualitative changes in the age, species and genetic structure of the province's forests that may impact timber values. Su et. al. 1996, cited in Section 8.1.2 below, link species diversity with resilience to spruce budworm. Evidence in Volume 2, Chapter 8, indicates that different harvest methods may impact the quality and value of timber (including availability of large diameter, clear lumber) in ways that directly impact market prices. Clearly, further work is necessary to assess the applicability of this evidence to particular Nova Scotia conditions. Jorg Beyeler points out (2001) that measured growth on NSDNR's permanent sample plots over 30 years does assess actual growth rates following clearcuts. Important scientific evidence particular to Nova Scotia could be gathered by comparing that evidence with control studies on soil quality, timber productivity, and other factors conducted on selection-harvested woodlots, such as that described in Volume 2, Chapter 1. At the very least, prudence requires an acknowledgement that qualitative factors may indeed significantly influence long-term timber productivity, growth rates, and, most importantly, timber quality. That recognition would lead to Nova Scotia-specific control studies that could substantially influence future wood supply models and management systems.

2) If the current condition of Nova Scotia's forests is less than optimal, then sustainable management may require some abstinence from harvesting in order to restore its potential quality. Rather than taking current conditions as the norm from which to make future projections, it is possible to take the quality and condition of Nova Scotia's original Acadian forest as the norm, and to see current age and species structures as reflective of a degraded condition. Volume 2 of these accounts explores restoration forestry investments in some detail, and also examines the potential to increase both market value and employment per unit of biomass harvested. Just as a moratorium on cod fishing is required to rebuild fish stocks, so it is argued by several foresters cited in Volume 2 of this study, some restraint is required in harvest targets in order to restore the value of Nova Scotia's forests to their real potential.

Both these assumptions may lead to different conclusions than those based on current wood supply models, increased silviculture inputs, and a doubling of harvest targets. It must be emphasized that GPI Atlantic does not argue here that its own assumptions and approach are necessarily at cross purposes with the NSDNR's new Forest Sustainability Regulations. On the contrary, the fact that these regulations support selection harvest management that was never previously eligible for support in previous silvicultural programs indicates a potential common ground that can incorporate the results of this study into NSDNR's own policy and planning processes.

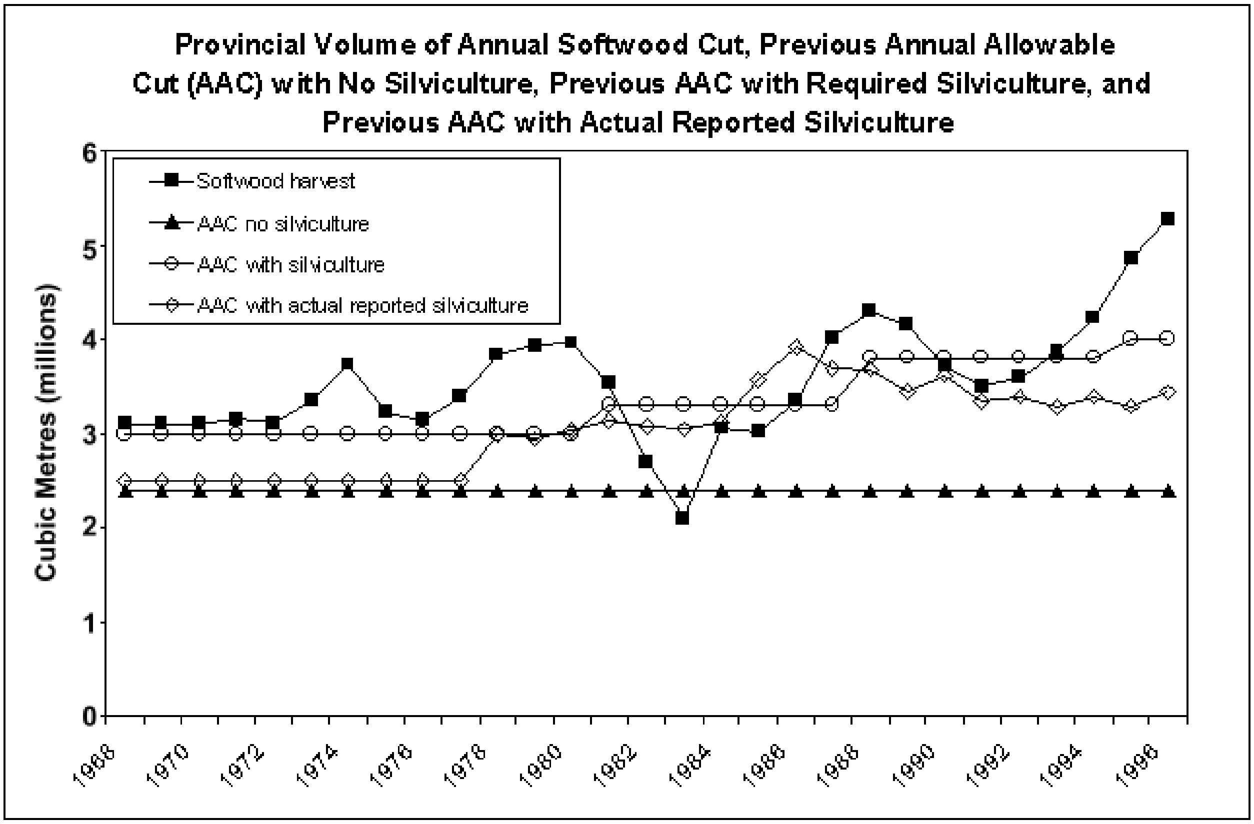
An analysis of the previous wood supply model and the derived PWS illustrates some of the problems that have arisen in the past from using wood supply modelling (Figure 14). For instance, as noted earlier, the silvicultural inputs that are used in the assumptions of the analysis are often not realized. As Figure 14 shows, actual reported silviculture remained substantially below required levels throughout the 1990s. Given the large percentage of land privately owned in Nova Scotia, wood supply planning and silvicultural programmes are inherently difficult.

The newly implemented NSDNR programs (Registry of Buyers and Forest Sustainability Regulations) will certainly help address some of these past problems, notably improving the accuracy of harvest statistics and providing more substantial financial incentives for silviculture.

However the new regulations do not begin to address more fundamental challenges to the wood supply analysis, like the exclusion of other forest values, including wildlife habitat, tourism, watershed protection, and biological diversity, that signal forest quality, integrity, and health. Because the wood supply analysis projects a sustainable wood supply based only on expected regeneration inputs (silviculture and natural regeneration), qualitative considerations are *ipso facto* excluded from the analysis.

As noted, these qualitative considerations are not separate from quantitative projections. The NSDNR harvest targets for 2070 do not address the possibility that nutrient and organic matter losses due to increased clearcutting could reduce timber productivity, quality, and market value. Nor do they consider that declining tolerant and semi-tolerant hardwood species, and conversion to single-aged, often single-species softwood stands, may reduce forest resilience and increase susceptibility to spruce budworm, other insect infestation and disease, resulting in unanticipated losses.

Figure 14. Provincial Volume of Annual Softwood Cut, Previous Annual Allowable Cut (AAC) with No Silviculture, Previous AAC with Required Silviculture, and Previous AAC with Actual Reported Silviculture



Sources: **Annual harvest of softwood**: National Forestry Database; **AAC with no silviculture**: based on estimate from the Nova Scotia Department of Lands and Forests Royal Commission on Forestry, 1983; **AAC with silviculture**: based on the predictions by DNR using the SAWS computer model; and **AAC with actual silviculture**: based on actual reported planting, pre-commercial thinning.

c) Beyond GDP and AAC

There is an interesting parallel here with the GPI critique of the misuse of GDP and economic growth statistics to assess societal well-being. Like measures of progress based on the GDP, wood supply analysis and PWS estimates use simple *quantitative* aggregates to assess a *qualitative* outcome, in this case "sustainability." Rates of harvest and planting are certainly one part of the sustainability equation, just as income levels and employment rates are part of any measure of progress. But the former does not in itself equate with forest health and sustainable use, just as the latter does not equate with well-being and quality of life.

At a time when the UN, World Bank, IMF, OECD and other international agencies have explicitly recognized the limitations and shortcomings of the GDP, there is no reason to continue misusing it to assess societal well-being and progress. Better measures are now available. Similarly, when both the Canadian Council of Forest Ministers and the international Montreal Process have clearly recognized and defined sustainable forest use as the maintenance of a wide range of forest values, there is no reason for continued adherence to narrow measures that essentially misuse the term "sustainability."

As the chapter headings of this study indicate, the CCFM and Montreal Process criteria and indicators for sustainable forest use include conservation of biological diversity, maintenance of ecosystem health, conservation of soil and water resources, forest contributions to global ecological cycles, and multiple benefits to society, in the sustainability equation. Better measures than AAC are now available to assess sustainable forest use.

In sum, healthy forest ecosystems can not be managed solely for wood supply, and they inherently will not function as simple timber input-output machines, as existing models assume. A much wider range of options for forest uses and non-uses must be evaluated before the operable forest area and wood supply analysis are calculated. For example, if a forest provides protection for watersheds, stream flora and fauna, wildlife habitat, and soils; if it is storing significant quantities of carbon; and providing tourism benefits and recreational opportunities, then that forest may already be contributing greater economic and ecological benefits left alone rather than clear-cut.[61]

Studies in both British Columbia and the U.S. national forest system have found that standing forests can contribute more each year to the GDP in recreation and tourism benefits alone than can be realized through logging (Talberth and Moskowitz 1999). Another study found that the forested watersheds upstream from New York City, if protected and maintained for forest ecosystem integrity, could save New York City $US9 billion over ten years in avoided water filtration costs, for savings of $21,718/ha over the first ten years (Parlange 1999). After accounting for purchase and restoration costs amounting to $4,826/ha, the net value of that standing forest was estimated at $17,000/ha over those ten years.[62]

Just as the GPI does not deny the legitimate use of the GDP for the purpose that its architects intended, so nothing in the present analysis denies the importance of timber supply as an important function and value of forests. Volume 2 of these forest accounts explicitly examines tested methods of ensuring a sustainable timber supply *within the context* of the maintenance of a full range of forest functions. That analysis, based on actual working models of sustainable timber harvesting in Nova Scotia and elsewhere clearly demonstrates sustainable forest use in a more comprehensive sense of the term, according to CCFM criteria. It also shows how the maintenance of a wide range of forest ecosystem functions can actually enhance timber productivity and unit value.

In the meantime it is not enough for the potential wood supply (PWS) to be determined by quantitative criteria alone. If they are to provide a guideline for forest health and quality in Nova

[61] Eldon Gunn, Department of Industrial Engineering, Dalhousie University, notes that wood supply and other forest benefits are not mutually exclusive, and that different CCFM indicators deal with other forest uses. The GPI analysis in these forest accounts accords completely with the first point for those instances where a forest is managed to protect all its values, as in the case studies in Volume 2. While other CCFM indicators do deal with other forest functions, GPI analysis is always concerned to elucidate the interdependence among social, economic and environmental indicator sets, and thus includes mention of other forest uses in a section on wood supply.
[62] The example does not imply equivalent dollar values for Nova Scotia, but simply indicates that a standing forest may have considerable economic value providing a non-timber ecosystem service.

Scotia, and for sustainable forest use that will benefit future generations of Nova Scotians, annual cut estimations will have to include qualitative criteria. They will need to include specifications of forest type, cover, age, species, and condition that consider the range of forest values and indicators specified by the Canadian Council of Forest Ministers. It is hoped that the development of these GPI forest accounts, however preliminary, can assist in this process.

d) Actual Annual Cuts

As already noted, dramatic changes in species composition may have important effects on both the qualitative and quantitative values of Nova Scotia's forests. The species distribution, age distribution, and number of large diameter trees have all dramatically changed since European settlers arrived in the province, with high-grading (i.e. removing the most valuable timber) a primary cause of the historical decline in forest value observed in the first two provincial forest inventories in 1912 and 1958.

This situation has changed, partly because the loss of the province's old-growth, multi-aged, multi-species forests no longer makes high-grading a viable economic option. Since the 1970s, the most prominent disturbance to Nova Scotia has been large-scale clearcut logging. More recent dramatic changes in species and age distribution are evident from the analyses in Section 7.1.2 and 7.2.2 above, which reveal a rapid and continuing decline in forest age diversity as well as declines in many forest tree species. These current trends are due primarily to clearcut logging, which accounts for 99% of timber harvesting in Nova Scotia.

The provincial forest area clearcut has doubled since the early 1980s, with the most dramatic increases in both area and volume harvested occurring between 1992 and 1997 (Figure 15). In less than a decade, the area clearcut rose from approximately 35,000 hectares in 1992 to 68,718 hectares in 1997, an almost 100% increase in area.[63] At the same time, the number of seedlings planted peaked in 1988 and has decreased substantially since that time from 31 million in 1988 to 12.5 million in 1996 (Table 8).

The area of silvicultural applications shown in Figure 15 follows a similar trend to the volume data for silviculture, increasing from 1975 to the late 1980s, and then declining. In short, even in simple quantitative terms that take no account of changes in forest quality, there has been a clearly unsustainable pattern in the 1990s of increased harvests based on the premise of a PWS inflated by silviculture inputs that have not been undertaken.

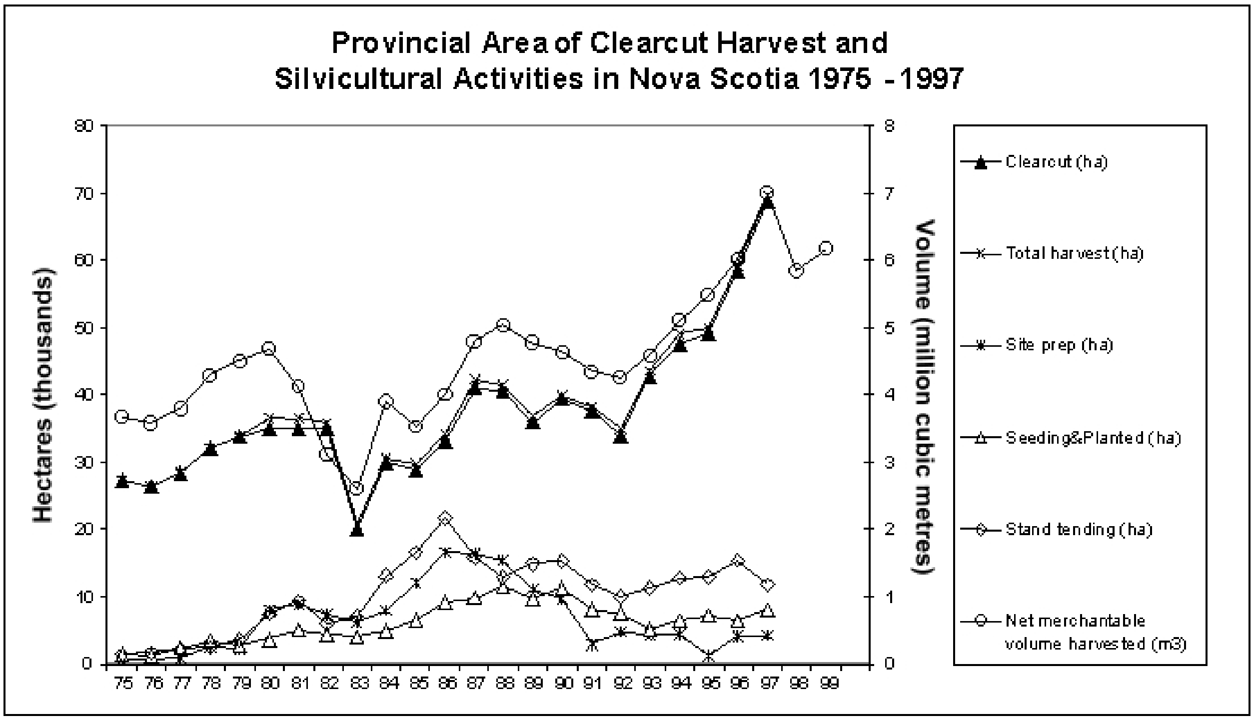
While the new NSDNR regulations are designed to close that gap, the trends of the 1990s also demonstrate one of the fundamental shortcomings in AAC/PWS methodology and use described above. Because the PWS model is based on projected silvicultural inputs that are used to assume an increased mean annual tree growth, the potential wood supply will be considerably inflated

[63] Source: Natural Resources Canada, *National Forestry Database Program.* Eldon Gunn, Department of Industrial Engineering, Dalhousie University (2001), points out that with a mean annual harvest of 5.4 million m^3 from 1996 to 1998, and an area of nearly 70,000 ha clearcut, the harvest was only 77 m^3 / ha. He notes that, on a volume per hectare basis, this number is very low, indicating that "either the trees were awfully young, or awfully old or the stocking was very bad."

when actual silvicultural inputs do not match expectations. Even without considering the qualitative changes in species and age distribution that are taking place, Figure 15 does illustrate the growing gap between the total area or net merchantable volume harvested and the regeneration activities that allowed an inflated annual allowable cut in the past. That steadily growing gap through the 1990s produced ever more unrealistic projections and unsustainable harvest volumes.

As Figure 15 demonstrates, the 1996 softwood cut exceeded the AAC with required silviculture, as set in 1982, by over 1 million cubic metres, and it exceeded the AAC with actual reported silviculture by almost 2 million cubic metres. In other words, even the AAC with all its conceptual inadequacies, has not successfully guided actual harvest levels, which have climbed to 60% higher than AAC calculations based on actual reported silviculture.

Figure 15. Provincial Area of Clearcut Harvest and Silvicultural Activities in Nova Scotia, 1975-1997



Source: National Forestry Database.

Table 8. Number of Seedlings Planted, Nova Scotia, 1988-1996

Year	Number of Seedlings Planted
1988	31,005,000
1993	10,473,000
1996	12,573,000

Sources: National Forestry Database, and NSDNR.

In total, the amount of wood volume harvested annually in Nova Scotia has doubled since the early l980s, from an average of 3.3 million cubic metres between l981 and l985 (NSDNR l997) to 6.5 million cubic metres in 2000 (NSDNR 2001).[64]

The alarming trends of recent years, and the warnings in the National Round Table report that Maritime woodlots may be on the verge of a resource collapse analogous to that in the ground-fishery, can only be understood in relation to technological changes (NRTEE 1997). Some analysts have implicated industrial fishing practices, increased industry concentration, and dragnet trawling not only in over-fishing but also in decimating the ocean-bottom benthic environment that provides an essential link in the ocean food chain. Similarly, the dramatic increase in clearcutting in recent years is related both to the introduction of logging machinery capable of cutting more trees in a shorter time span, and to highly automated high-volume mills that have created an insatiable demand for wood supply.[65]

e) Natural Regeneration and Sustainable Forest Management

As noted earlier, PWS estimates are based on both natural regeneration and silviculture. The uncertainties inherent in silviculture projections described above do not hold for natural regeneration which occurs far more predictably in Nova Scotia. Inputs for the PWS include the natural mean annual tree growth rate (mean annual increment, MAI) in the province.[66]

According to the CCFM (l997), the mean annual increment (MAI) in the Atlantic Maritime region ranges from 1.6 to 1.94 m3/ha/year for softwoods, and 1.59 to 2.00 m3/ha/year for hardwoods. The most recent numbers from Permanent Sample Plot data (NSDNR 2000a, NSDNR 2000b) indicate that the average growth rate in Nova Scotia for softwoods and hardwoods on all lands is 2.05 m^3/ha/year. When multiplied by the total operable forest land in the province (2.616 million ha) the MAI for operable forest lands is 5.36 million m^3/yr. This is well below the total volume harvested (6.5 million m^3) in 2000. In multi-aged natural forests, the MAI would appear to be a much sounder basis for quantitative assessments of sustainable yield than the PWS, due to the former’s consistency and reliability.[67]

The Department of Natural Resources has taken steps towards addressing the issue of inaccurate harvest and silviculture estimates by creating the new Registry of Buyers and Forest

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[64] For more detailed actual annual harvest information refer to Figure 18 in Volume 2 of the Forest Accounts.
[65] See Volume 2, Chapter 9, for a further discussion on the impact of mechanization.
[66] The following definition of mean annual increment (MAI) is from the Ontario Ministry of Natural Resources' Silviculture Guide for the Great Lakes St. Lawrence Conifer Forest in Ontario: "The average annual increase in volume of individual trees or stands up to the specified point in time. The MAI changes with different growth phases in a tree's life, being highest in the middle years and then slowly decreasing with age. The point at which the MAI peaks is commonly used to identify the biological maturity of the stand and its readiness for harvesting" (Ontario Ministry of Natural Resources 1998a).
[67] E. Gunn (2001) points out that the MAI is low in both old and very young forests, and that harvest levels should not therefore be expected to bear a relationship with the *current* MAI, because that is “a function of the current age class structure.” However, the MAI can be calculated as the average yearly growth rate over the life of a stand of trees. Both Pictou landing (Volume 2, Chapter 2) and the Haliburton Forest in Ontario (both FSC certified) rely on MAI to calculate sustainable yields.

Sustainability Regulations. 'Registered buyers' include the sawmills and pulp mills buying wood from private woodlots. The Registry will keep track of the amount of timber actually cut in the province, and the regulations require forest product companies to reinvest money and resources back into private woodlands in proportion to the volume of wood taken from those lands. These regulations will create a better account of the amount of timber actually cut in the province, and will encourage higher levels of silviculture.

In the long run, however, a much more far-reaching combination of legislation, incentives, and monitoring is necessary to ensure genuinely sustainable levels of harvest, and ecologically sustainable cutting methods that protect the full range of forest values. This may well include incentives that favour selection and shelterwood methods over clearcutting, and that place greater restrictions on the volume, area, and location of clearcutting. In order to correct some of the problems identified in this analysis, the following actions are necessary:

a) regulations and enforcement for best forest management practices on both private and crown lands;
b) incentives, education, and policy for best practices in forest management on small and large privately-owned forested land;
c) monitoring and assessment of harvesting and silvicultural activity on privately-owned lands; and,
d) incentives and education for landowner options to protect privately-owned primary forested land, and areas of unique, cultural, and biological importance.

Above all, such legislation, incentives, and monitoring must be based on a more accurate and comprehensive accounting system than currently exists. As long as regulations and incentives are based on quantitative accounts that exclude changes in critical factors, they will not prevent the ongoing loss of Nova Scotia's mature, multi-aged, multi-species forests. New forest accounts based on the CCFM criteria and indicators should be adopted and implemented in practice as soon as possible.

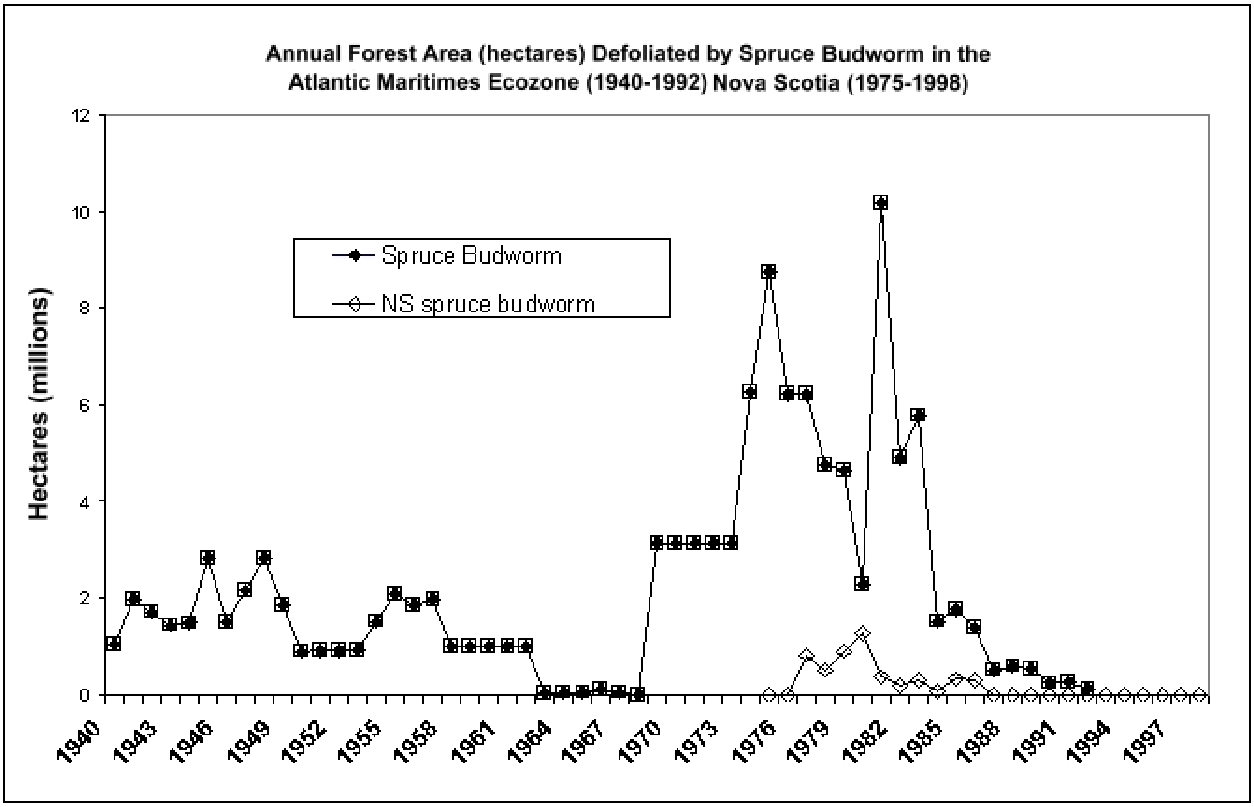
8.1.2 Area and severity of insect attack, disease infestation, and fire damage

The percentage of harvestable forest volume lost to insects, fire and disease in Nova Scotia has been minimal over the last several years. Between 1994 and 1997, less than 5% of the harvestable forest volume has been affected in this way (NS Counts, Government of Nova Scotia).

Figure 16 shows the forest area in the Atlantic Maritimes defoliated by the spruce budworm between 1940 and 1992. The area affected by spruce budworm greatly increased from the 1970s through 1983 and then decreased dramatically from 1983 to 1992. The losses in Nova Scotia were only a small percentage of the losses in the Maritimes as a whole, with New Brunswick bearing the brunt of the infestation. Figure 17 shows the effect of hardwood content on predicted budworm damage.

According to a Department of Natural Resources research report (NSDNR 1994), the volume of merchantable spruce and balsam fir on Cape Breton Island was reduced from a projected volume of 45 million m^3 to 13 million m^3, a decrease of 70%, as a result of the spruce budworm infestation from 1974 through 1981. The loss in volume of balsam fir was the highest (79%), followed by white spruce (75%), and red and black spruce (54%), with a total loss amounting 32 million m^3 (14 million cords). This decline produced an economic loss of $191.27 million in stumpage fees.[68]

Figure 16. Annual Forest Area (hectares) Defoliated by Spruce Budworm in the Atlantic Maritimes Ecozone (1940-1992) and Nova Scotia (1975-1998)



Source: National Forestry Database.

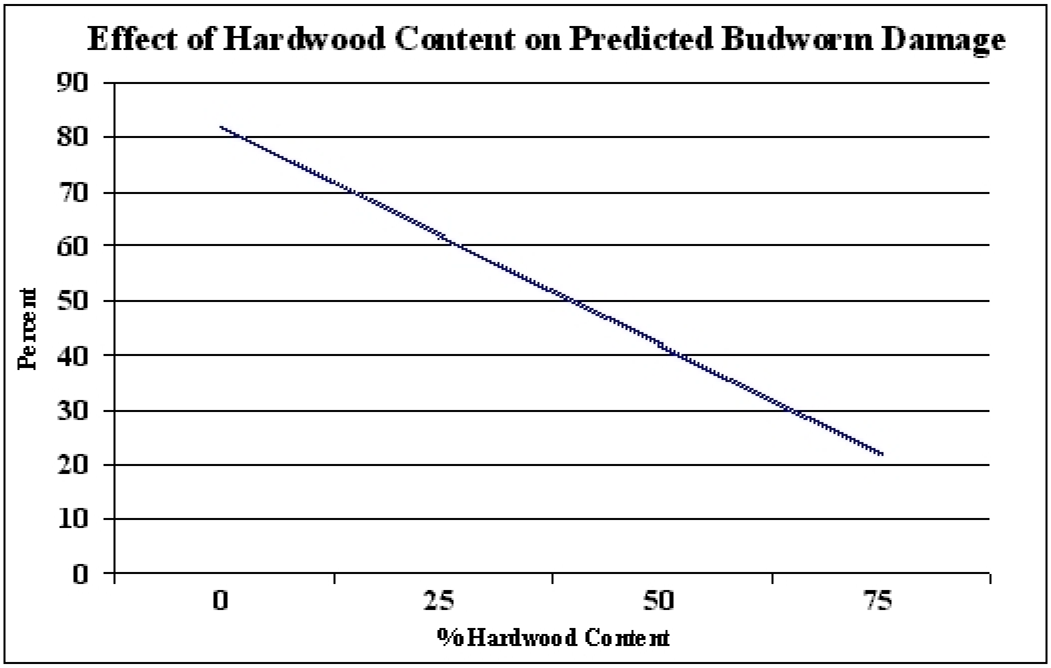
The NSDNR (1994) study found that softwood and mixed wood stands suffered similar losses (71% and 73% respectively) in spruce and balsam fir volume. However, the spruce and balsam fir components of hardwood stands were reduced by only 46%.

The influence of hardwood trees in reducing the rate of defoliation due to spruce budworm infestation was carefully studied by Su et. al. (1996) in 25 mixed balsam fir-hardwood stands in New Brunswick between 1989 and 1993. Their research took place during moderate to severe regional defoliations by spruce budworm. They found that defoliation by spruce budworm was

68 Stumpage fees lost are based on the 1996 License Agreement rate for pulpwood softwood (National Forestry Database).

significantly (p<0.0001) related to the hardwood content of a forest. As the hardwood content increased, the defoliation of the balsam fir within the stands decreased.

Figure 17. Effect of Hardwood Content on Predicted Budworm Damage



Su et. al. (1996) ascertained that balsam fir stands with less than a 40% hardwood component sustained an average of 58-71% defoliation, whereas stands with greater than 80% hardwood sustained 12-15% defoliation (Figure 17) They developed a model combining hardwood content of stands and the estimated defoliation in pure softwood. The model demonstrated that mixed balsam fir - hardwood forest stands with greater than 40% hardwoods present could substantially reduce losses during spruce budworm outbreaks, a finding that has profound implications for the linkage between species diversity and forest economic values in Acadian forests.

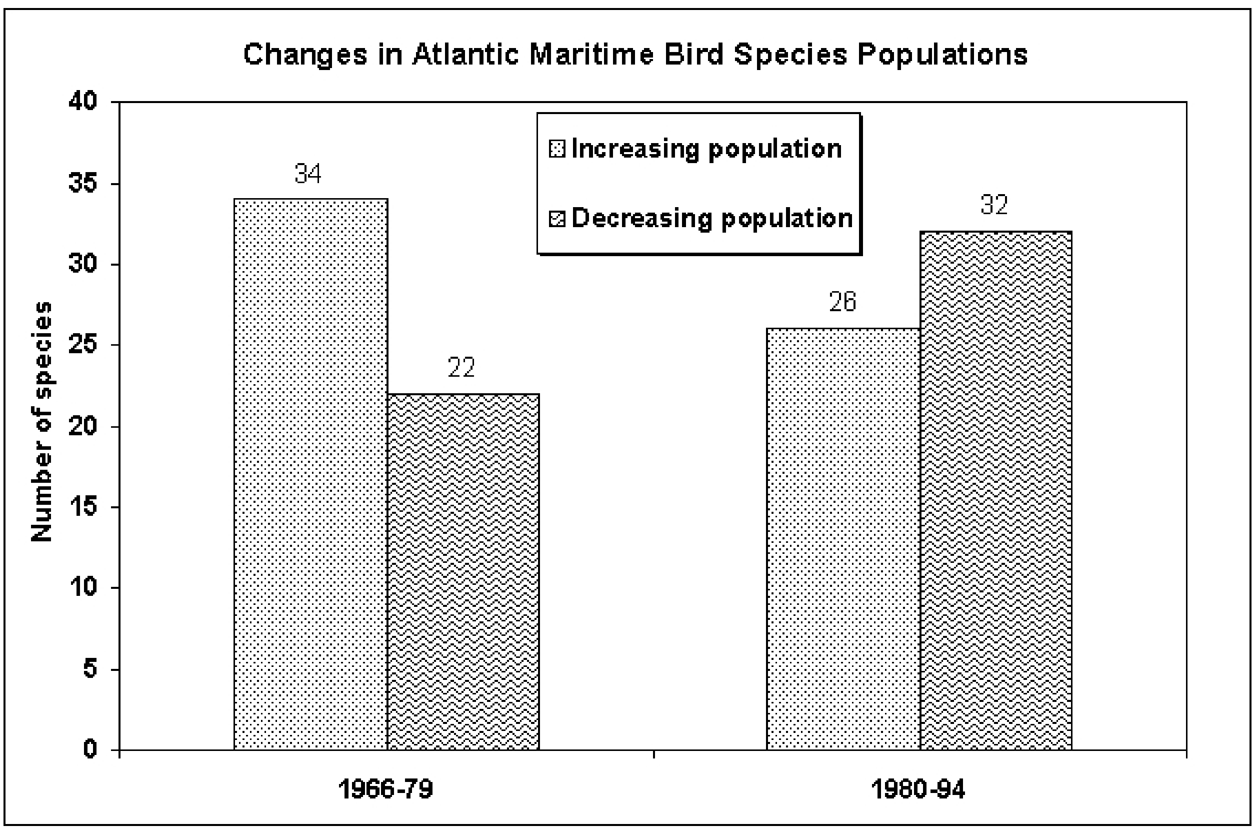
Su et. al. (1996) also suggested that the greater hardwood content increased the diversity of populations of birds and parasitoids, typically natural predators of the spruce budworm. Their findings confirmed earlier research in northern New Hampshire and Maine that also studied the predation of spruce budworm by birds. Crawford and Jennings (1989) found that the percentage of budworm populations consumed by birds was effective in controlling populations when budworm populations were low. However, when budworm populations reached higher densities, bird predation was less effective. They concluded that birds can effectively limit budworm increases before they reach high densities.

Crawford and Jennings (1989) also concluded that the number of birds could be increased through judicious use of silvicultural practices, but they emphasized that this would require a major change to the dominant commercial forestry methods in use. For example, they suggested that shelterwood forest management be adopted for even-aged stands and selection forest management for uneven-aged stands in order to maintain and create habitat that would encourage bird populations in managed forests.

In addition, a third study concluded that both species *and* age diversity could provide effective controls against spruce budworm infestation. The researchers found that uneven-aged management practices such as selection logging successfully enhanced the habitat for birds that prey on spruce budworm (Crawford et. al. 1983). These linkages clearly demonstrate that non-market, non-timber values like habitat for wildlife and biological diversity can have a vital protective function for forest timber values, and yield long-term economic benefits in ways that are not currently acknowledged in the conventional timber accounts.

Unfortunately, declining bird counts in the last 20 years indicate that there may be losses of specific forest habitats required by certain bird species in the region. Figure 18 shows that there are now 32 species of birds with declining populations in the Maritimes, a 45% increase in the number of bird species with declining populations since the 1970s. This decline is a direct indicator of the overall health of bird populations in the Maritimes. It may also signal a declining ability of Maritime forests to maintain a balance in natural forest populations, and to support vital predator species that can protect against future spruce budworm and other insect infestations.

Figure 18. Changes in Atlantic Maritime Bird Species Populations



Source: Canadian Forest Services, Natural Resources Canada, Ottawa, Ontario.

Ecosystem functions are inherently interrelated in complex webs of causation that demand respect, if critical natural services to human society are to be maintained. For example, New Brunswick sought to control the spruce budworm outbreaks of the 1970s and 1980s with large-scale insecticide spraying that has now been linked to the sharp decline in Atlantic salmon (*Salmo salar*) populations in several New Brunswick rivers (Fairchild et. al. 1999). Department of Fisheries and Oceans (DFO) researchers first found a significant relationship between the tributaries sprayed with Matacil® 1.8D in the Restigouche River drainage basin in New Brunswick, and declining salmon returns.

They then investigated other areas sprayed, and found that a significant proportion ($p<0.005$) of the lowest salmon catches for 16 rivers between 1973 and 1990 coincided with the spraying of Matacil® 1.8D. A decline in blueback herring (*Alosa aestivalis*) was also apparent. The primary solvent, 4-NP, was found to be the cause of the declines, due to interference with natural spawning mechanisms. According to Fairchild et. al. (1999), similar concentrations of 4-NP are present in current industrial effluents and municipal sewage outfalls.

Fortunately, there was relatively little insecticide sprayed in Nova Scotia when compared with other regions,[69] a factor that may have contributed to the much shorter duration of the budworm infestation in this province, and the consequent lower intensity of losses. Historical records indicate that spruce budworm outbreaks have long been a natural part of the forest disturbance cycle in the Maritimes, and an integral part of natural forest successional processes. However budworm attacks in the 1800s and early 1900s appear to have been much shorter in duration and to have produced far lower rates of defoliation and loss than the most recent outbreak of the 1970s and 1980s. The comparative intensity of that recent infestation may have been caused by past cutting practices, related to the decline in old-growth forest characteristics and natural species diversity, including bird populations.

These are indicators that vital linkages exist between harvesting methods, maintenance of natural species diversity, bird populations, use of pesticide controls in forestry management practices, and the quality of salmon rivers. At a more profound level, the examples provide a portrait of the inter-connectedness of forest quality, ecosystem health, and future natural wealth, and they warn of the potential decline in that wealth that can occur when natural checks and balances are not maintained.

NOTE: Because the GPI Forest Accounts are concerned to follow the indicator frameworks of the Canadian Council of Forest Ministers and the Montreal Process, the following indicators are included in this section on disturbance and stress (8.1), even though data are not currently available in several cases. This listing is therefore designed to illuminate data gaps and to suggest areas for further research.

[69] Peter Macquarrie, NSDNR, (pers. comm. 2001), points out that only BtK has been used as an aerial insecticide in NS in modern times.

8.1.3 Rates of pollution deposition

Forest ecosystem health is also affected by air quality. As the devastation of many European forests has shown, wet deposition, normally called "acid rain," can be a particularly destructive influence for forests. Snow, rain and fog can carry nitrate and wet sulphate depositions from industrial sources hundreds of miles away, with sources in southern Ontario and the northeast United States impacting Nova Scotia.

Here it is simply noted that the Canadian Council of Forest Ministers (CCFM 1997) reports that acid rain continues to affect forest ecosystems negatively despite substantial progress in reducing SO_2 emissions in both the U.S. and Canada. Maples and birches, in particular, are exhibiting health problems in Nova Scotia due to acid rain. The CCFM (1997) reports average nitrate deposition for Nova Scotia of 5-10 kg/ha/year and average wet sulphate deposition of 10kg/ha/year for the years 1990-93.

The impact of acid rain is dealt with in more detail in the GPI water quality accounts (Wilson 2000), and the upcoming air quality report will include specific estimates of the costs of acid rain to Nova Scotia forests (Monette 2002). These estimates should be included in future updates of this report.

8.1.4 Ozone concentrations in forested regions

Another air quality factor that can impact forest ecosystem health is tropospheric or ground-level ozone, which may have negative effects on plant metabolism, and is known to cause tree mortality at critical levels. Ground-level ozone can also cause changes in carbon allocation, premature defoliation, loss of plant productivity, and ecosystem structure and function. It has not been possible in this study to estimate potential impacts, if any, of ground-level ozone on Nova Scotia forests.

8.1.5 Crown transparency

Crown transparency and dieback are good indicators of hardwood crown condition, while defoliation is the more common measure for softwood stands. Transparency refers to the amount of light that reaches through the dominant and co-dominant trees. Unfortunately, there are currently no aggregate provincial data available for these indicators. Field studies in these areas are essential for future updates of this report.

8.1.6 Area and severity of occurrence of exotic species detrimental to forest condition

No data were readily available for this indicator. An estimate for this indicator is recommended for future updates.

8.1.7 *Climate change as measured by temperature sums*[70]

In the 20th century, average global surface air temperature increased between 0.3 and 0.6°C, an increase that is larger and more rapid than at any other time in history (Suplee 1998). Globally, the 1990s were the warmest decade since the beginning of instrumental measurements in the 1860s, and they included 7 of the 10 warmest years on record. An international panel of scientists appointed by the United Nations (IPCC) has concluded that there is a significant warming trend that is likely due to human induced inputs.

Climate change can affect forest ecosystem health by influencing the range of plant and tree species, affecting growth and productivity, changing natural disturbance regimes including frequency of fires and droughts, and affecting moisture availability, which in turn influences growth, productivity and disturbances.

The United Nations' Intergovernmental Panel on Climate Change (IPCC 1996) predicts that global warming will increase forest fire losses by 140% globally, with $1.8 billion of annual damages to OECD countries alone. It may also lead to changes in the distribution of tree species, with some climate change models predicting warmer winters and springs, but cooler summers for the Maritimes. This could increase the growth rates of conifers, but late frosts or early extended thaws may be more damaging to hardwood species.

Environment Canada (1997) predicts that the Canadian forest industry will suffer due to climate change, as new northern forest ranges will not mature fast enough to compensate for predicted southern range declines. Soil organic matter, an important CO_2 sink, will also decompose faster as temperatures rise, decreasing the carbon sink value of forests and releasing carbon into the atmosphere. Forest productivity in Atlantic Canada may increase under current climate change models, but fire, insect, and disease outbreaks, as well as forest damage from wind-storms, are also expected to increase. Current uncertainties prevent any specific estimate here of the potential economic cost of climate change for Nova Scotia forests.

8.2 Ecosystem Resilience

This section follows logically from the previous one (8.1 Disturbance and Stress), because it reflects the capacity of forests to recover or "bounce back" from disturbance and stress. Evolution has provided species with the capacity for survival, resilience, and recovery. Adequate measures for ecosystem resilience, however, have been difficult to identify because of a lack of knowledge and understanding. The best indicators currently available to assess ecosystem resilience and recovery are forest types, age class distribution, and rate of successful regeneration.

[70] The information in this section is adapted from Walker et. al, *The Nova Scotia, Greenhouse Gas Accounts for the Genuine Progress Index.* GPI Atlantic, Halifax, 2001.

8.2.1 *Forest area by forest type and age class*

Assessments for this indicator are given in Section 7.1.2 above.

8.2.2 *Percentage of area successfully naturally regenerated and artificially regenerated*

A 1980 report by the Nova Scotia Department of Lands and Forests (Lands and Forests 1980) examined regeneration following clearcutting. The report found that approximately 45% of the cutovers dominated by softwood tree species prior to harvest had regenerated to predominately softwood stands. In addition, 74% of cutovers dominated by hardwood tree species had regenerated to shade-intolerant hardwoods with only 2% regenerating to shade-tolerant hardwoods.

The report results showed:

a) a significant change in the species composition of the province's forests; and
b) that regeneration of the natural forest following clearcut logging methods has been converting at least 50% of each forest type to a different forest cover type.

A more recent provincial regeneration study surveyed 374 unmanaged clearcuts aged four to seven years old. The draft report concluded that 69% of forest stands were at least 60% stocked by regenerating softwood species, and 63% of forest stands were at least 60% stocked by regenerating hardwood species (Stewart and Quigley 2000). The softwood stocking (69%) was dominated by balsam fir (33%), and spruce species (29%), and the hardwood stocking (63%) was dominated by shade-intolerant hardwoods (53% white birch, aspen, red maple). The overall stocking of the surveyed area by commercial species was 84%.

The results of this study show an improvement in stocking and regeneration. However, the reported stocking is predominantly balsam fir, white birch, aspen, and red maple, species that typically fetch lower prices, and are not as high in demand as red spruce, sugar maple, and pine. Large diameter logs of the latter species are especially in demand in Nova Scotia, New Brunswick, and Maine (deMarsh 1998).

Further work is necessary to assess the degree to which regeneration following clearcutting is resulting in more uniform and less natural Acadian forest types in Nova Scotia, and to evaluate post-clearcut forest quality compared to pre-clearcut forest quality. In order to assess whether there is a loss of direct market values and non-market values due to conversion, it will also be necessary to compare market prices of species, and different diameter logs according to pre-clearcut and post-clearcut composition. In short, the issue of regeneration is not simply a quantitative one, but involves potential changes of forest type that affect both market and non-market forest values.

Assessments of relative value are complicated by differences in the number of previous clearcuts on different forest lands, and by changes in relative soil productivity following successive clearcuts. These analyses have not been attempted for this study, but should be included in future updates of this report. Soil sample analyses should be reported regularly by the NS Department of Natural Resources in order to investigate further the correlations between alternative harvesting methods, soil quality, timber productivity, forest resilience, and species composition in Nova Scotia.

Understanding the linkages between timber harvesting methods, regeneration, and future productivity is vital if we are to preserve the value of the province's natural forest wealth for the benefit of future generations. Losses in quality can be subtle and long-term, and may thus escape attention until the changes are irreversible. Investment in research and reporting in these areas can yield significant long-term benefits.

8.2.3 Area and percent of forest land with diminished biological components indicative of changes in fundamental ecological processes

This indicator of forest ecosystem health requires assessments of ecological processes such as soil nutrient cycling capacity, seed dispersion, pollination, and ecological continuity, including the monitoring of functionally important species such as fungi, arboreal epiphytes, nematodes, beetles, and wasps. Provincial data are not currently available for this important indicator, and field studies are required.

9. Conservation of Soil & Water Resources

a) Physical environmental factors

Forests provide several benefits and services regarding soil quality, water quality, and conservation. Firstly, forests protect soils by breaking the impact of rain drops on the soil, and by slowing the run-off of water across the soil, thereby preventing erosion. Both functions are important for site productivity and water quality. Secondly, forest ecosystems in general, and forested watersheds in particular, provide benefits in safeguarding water supplies and fisheries (both freshwater and coastal) by controlling sedimentation, and maintaining appropriate water temperatures and nutrient availability. The maintenance of appropriate levels of soil oxygen, nutrients, moisture, and organic matter are essential for the long-term productivity, resilience and sustainability of forest ecosystems (CCFM 1997), and thus have a direct bearing on the economic and timber values of forests.

b) Forest Watershed Services

According to Myers (1997), forests provide watershed services that are often overlooked. They control soil erosion, prevent sedimentation of streams and coastal waters, maintain stream habitat and microclimate, and maintain and regulate water supply and flows. Forest canopies help break the impact of rain on the soil, and capture rainwater in the leaves, branches and trunks of trees. They create a slower flow of water to the forest floor, the soil, and into streams.

Studies have found that a large amount of rainfall never reaches the ground in a forest. For example, an undisturbed tropical forest intercepts, on average, at least 35 % of rainfall, whereas a logged forest intercepts less than 20%, and a plantation only 12 % (Myers 1997). In fact, interception percentages can be significantly higher in some other forest types. In forests with conifer trees (evergreen), 1/3 to 1/2 of the precipitation is intercepted by the forest canopy and does not reach the soil directly; in maple-beech forests 43% of falling precipitation is intercepted, in Douglas-fir forests 34%, and in Ponderosa Pine plantations 22% is intercepted (Brady 1990).

Different forest harvesting techniques will also impact soil and water quality differentially. For example, the degree of soil compaction is dependent both on the season in which harvesting takes place (i.e. frozen ground with snow cover versus unfrozen ground), on the machinery used to extract timber, and on the width of wheels of harvesting machinery. The degree of soil compaction in turn affects the soil's ability to absorb falling precipitation.

In addition, the degree of canopy removal directly affects water interception, and micro-climate (i.e. temperatures on-site). For example, selection harvesting methods maintain more canopy cover than clearcutting, thereby maintaining a higher percentage of canopy interception. Following a clear-cut, canopy interception function is temporarily lost, creating increased run-off, and potentially negative impacts on soil quality and stream water quality. Therefore, indicators such as forest canopy cover, height, and fragmentation need to be assessed, measured, and monitored on a regular basis in Nova Scotia in order to assess the present ability of the forest to protect the soils on which future forest and timber productivity depends.

Long-term research of forestry impacts in the northeastern United States has found substantial increases in water flows following forest clearing due to reductions in transpiration and canopy interception (Hornbeck et. al. 1993). However, these results showed that increases in water flow due to logging usually did not persist for more than 10 years after cutting *unless* regrowth was controlled with herbicides. The results also indicated that intermediate cuttings, thinnings and/or repeated herbicide applications doubled the time period over which substantial water flow increases occurred. In other words, these management techniques allowed substantially increased water flows to persist for 20 years or more, with potentially deleterious impacts on soil quality. Further research specific to Nova Scotia is urgently needed to assess the effects of logging methods on watersheds and soil productivity and to determine the economic and environmental costs we may be incurring.

9.1 Soil Quality

9.1.1 Control of Soil Erosion and Linkages with Fisheries

After logging, streams and coastal areas can be affected by increases in sedimentation and water run-off from a logged site. As noted above, increased nutrient loads and water flow result for up to 10 years under natural regeneration and up to 20 years when repeated herbicide applications, and/or intermediate thinnings or cuttings occur. Riparian (i.e. riverbank) forest trees and plants also shade streams and rivers, playing a key role in maintaining water temperature and habitat. Changes in water temperature can have a dramatic effect on stream ecosystems. Cutting close to stream and riverbanks can therefore have serious environmental impacts.

According to several sources, tropical deforestation-derived siltation is causing problems for ports, fisheries, spawning streams, and water supplies globally (Mahmood 1987, Myers 1997). The global costs of siltation of hydropower and irrigation-system reservoirs are estimated at $6 billion per year. In addition, the environmental costs of sedimentation for fisheries have been assessed in several places. For example, several parts of the Philippines' coastal zone fisheries are declining due to inland deforestation, with estuaries being filled with sediment from the inland watershed catchments (Myers 1997).

Forests in the Philippines provide watershed protection for fisheries worth $6.2 - $8.1 million per year, a net present value of $58 per hectare for forest-derived protection of fisheries (discounted at 8%), including flood control benefits, soil fertility maintenance, and the lost opportunity cost of logging by local people. Although this is a tropical forest example, a similar value could potentially be extrapolated or estimated for Nova Scotia both as a province and on a community scale. This is important given the economic importance of the fisheries in Nova Scotia, and could be included in future updates of the GPI Forest Accounts.

There is currently an almost complete lack of information on these important indicators of soil quality, including soil erosion and compaction in Nova Scotia, and of the impact of forest practices on local fisheries, especially freshwater and recreational fishing. Significantly more research, monitoring, and field studies are needed, including regular soil sample testing, water temperature monitoring, and canopy height assessments, that can be related to harvest practices. An account of soil nutrients for the province's forest soils should be an essential component of future updates of the GPI Forest Accounts. The necessary research and field studies should be seen as a vital investment in protecting long-term forest quality and value in the province.

Because of this major data gap, it is presently also not possible to provide quantitative information on the following important CCFM and Montreal Process indicators of sustainable forest management.

9.1.2 Area and percentage of harvested area having significant soil erosion

Data are not currently available.

9.1.3 Area and percentage of harvested area with significantly diminished soil organic matter and/or changes in other chemical properties

Data are not currently available.

9.1.4 Area and percentage of harvested area with significant compaction, displacement, puddling, or changes in soil physical properties resulting from human activities

Data are not currently available.

9.2 Water Quality

According to Myers (1997), the price of water from a forested watershed catchment with undisturbed forest increases twofold after a forest is logged, and fourfold after uncontrolled logging. The costs of a degraded watershed are well illustrated by the recent purchase by New York City of a large portion of the watershed area for New York City's water supply (Parlange 1999). The municipality's other option was a filtration plant that would have cost about US$8 billion in capital expenditures, plus a US$300 million annual operating cost for New York City's water supply. Within 10 years, water filtration would have cost approximately $11 billion. However, the purchase and restoration of the watershed will cost less than US$2 billion, saving the city as much as US$9 billion over ten years.

In short, there is a direct economic value in the capacity of standing forests to provide water filtration services and to protect watersheds and water supply systems, a value that can produce very substantial long-term savings. This value is invisible in our standard accounting procedures. Conversely, the costs of losing that "free" service are also hidden when forested watersheds are logged. In fact, the conventional economic accounts, assessing only market values, count the cost of expensive man-made engineering replacements for that free service as contributions to economic growth and prosperity. Thus, a decline in forest quality, function, and watershed protection capacity paradoxically appears as economic gain in our current measures of well-being.

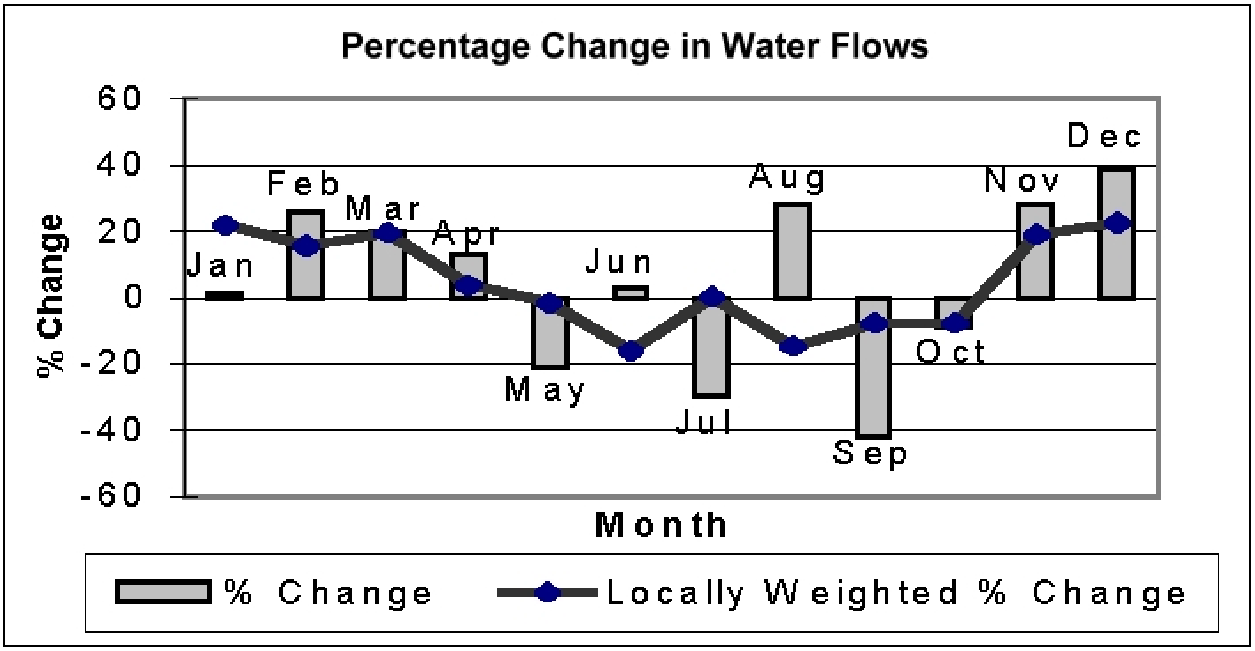
9.2.1 Water quality as measured by water chemistry, turbidity etc.

The availability of data for this indicator has not yet been determined.

9.2.2 Trends and timing of events in stream flows from forest catchments

The percentage change in water flow from 1922 to 1990 was calculated for five Nova Scotia rivers (South River, Beaverbank River, Medway River, LaHave River, and Margaree River). These rivers were chosen based on the availability of historical data. The results indicate an increase over time in flow of approximately 15-30% during February, March and April. This is followed by a general 20- 40 % decrease in water flow between May and September, with the exception of June and August. November and December also demonstrate an increase in water flow of 30% and 40%, respectively (Figure 19). In other words, there has been a substantial shift in seasonal flow patterns in Nova Scotia rivers over a 70-year time span, with substantially increased water flows in the winter months, and decreased flows in the summer months.

Figure 19. Percentage Change in Water Flows on Five Nova Scotia Rivers, 1922-1990



Firstly, an increase in water flow during the winter and early spring months could be attributed to a warmer climate as well as a possible decrease in forest cover due to urbanization, forest cutting, or agriculture, leading to decreased water retention and absorption capacity. Secondly, the relatively high decreases in water flow during the summer may be a result of a change in climate or a change in the hydrological cycling pattern. For example, local forest climate (micro-climate) is moderated by forest cover, which maintains cooler temperatures through shading. The forest cover also exchanges water moisture with the atmosphere, creating a micro-hydrological cycle. When forest cover is removed, both the local temperature and moisture cycle can be altered.

The land use patterns in these watershed areas have not been evaluated for comparison with the changes in water flow patterns over time. Future research should monitor water flow and water quantity in the major watersheds across the province in relation to land use patterns, in order to ascertain and compare changes in managed and unmanaged environments. Through such correlations it can be determined whether particular forest harvesting practices and the removal of forest cover in general have played a role in the observed changes in water flow patterns in Nova Scotia rivers.

This research is particularly important at a time when major declines in freshwater fish populations have been observed in many Nova Scotia rivers (see Section 9.2.4 below). The total number of recreational fish retained has dropped by 70% since 1975 and by 45% since 1990. This has had economic impacts, with an estimated loss to the Nova Scotia economy of $22 million over the past decade due to the decline in recreational fishing (Wilson 2000).

There are likely many factors responsible for this decline, including acid rain, climate change, over-fishing, introduction of exotic species, and pollutant depositions. It was also noted above that a recent DFO study has implicated forest insecticide spraying in salmon declines, due to the interference of the chemicals with spawning mechanisms.

However it is also important to determine the extent to which harvest practices themselves, including clearcutting and removal of forest cover, have affected water flow, water temperature, increased sedimentation, and fish populations. One ongoing study at Carnation Creek, British Columbia, is yielding valuable data on the impact of west coast forestry practices on watershed integrity. To the best of our knowledge, there is no comparable study in Nova Scotia.

9.2.3 Percent of stream kilometres in forested catchments in which stream flow and timing have significantly deviated from the historic range of variation

Data are not available for this indicator.

9.2.4 Changes in the distribution and abundance of aquatic fauna

Changes in the distribution and abundance of aquatic fauna may be due to many factors. Acid rain, climate change, over-fishing, sedimentation, and loss of forest canopy cover have all been implicated in salmon and trout population declines in Nova Scotia. This remarkably complex problem is clearly not due to any one factor (Duke 2001b). Nevertheless, these changes are considered here, as part of the CCFM and Montreal Process framework used for this study, because forest practices have been noted as a potential contributing factor to the changes described below.

a) Atlantic salmon populations

In June 1999, the Atlantic salmon population reached an all-time low of 80,000 large salmon (Borden 1999). The minimum conservation target is at least 201,000 salmon. A 1997 study found that Atlantic salmon have been extirpated from 14 Nova Scotia rivers, severely impacted by acid rain in 20 rivers, and moderately impacted by acid rain in 16 rivers, with only 13 rivers not experiencing acid toxicity (Watt 1997). A 1999 count found that Atlantic salmon are now extinct in 22% of Nova Scotia salmon rivers; another 25% of the province's salmon rivers have depleted stocks; and 32% have only remnant populations (Watt and Hinks 1999). In 1999 only 22 of Nova Scotia's 72 salmon rivers were open to recreational salmon angling.

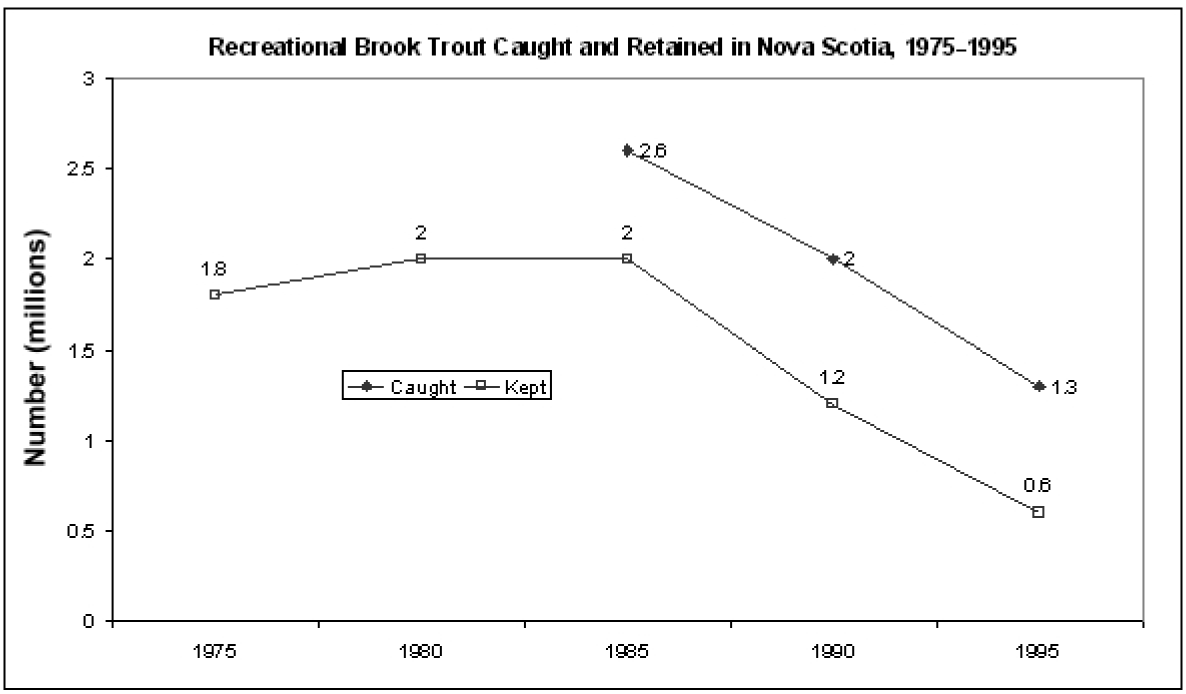
Most Nova Scotia salmon rivers continue to maintain Atlantic salmon stocks well below the conservation requirement. For example, in the LaHave River, (one of the five noted above that were monitored for water flow changes), the mean count was only 187 multi-winter salmon between 1994 and 1999, whereas the conservation requirement is 1,320 above the Morgan Falls pass.[71] Salmon returns in the LaHave River have dropped by 45% since 1994 alone.

Salmon stock declines have been costly. Prior to the stock collapse, the salmon recreational catch was worth more than $3 million a year, and the federal government has now spent $1 million buying back commercial licenses. For further analysis of trends in Atlantic salmon populations, see Wilson (2000).

b) Brook trout populations

According to Clay (1988), brook trout should be considered a forest-dwelling species because trout are limited by the higher stream temperatures attained in summer in water where there is a low proportion of canopy cover. In other words, forest shade is considered an essential habitat requirement for this species. Using recreational fishing catch and retention figures as an indicator, brook trout populations in Nova Scotia appear to have declined dramatically since 1985 (Figure 20). The number of brook trout caught declined by 50% between 1985 and 1995, from 2.6 million to 1.3 million, and the number retained declined by 70% from 2 million to just 600,000 (Wilson 2000). This sharp decline may be the result of several changes in habitat such as warmer water temperatures due to reduced forest canopy cover, sedimentation, over-fishing, and acidification of rivers.

Figure 20. Recreational Brook Trout Caught and Retained in Nova Scotia, 1975-1995



Source: Department of Fisheries and Oceans Recreational Fisheries Statistics.

[71] Atlantic Salmon Rivers of the North Atlantic/ Canada SeaLane website: www.asf.ca/rivers/default.html.

9.2.5 Percentage of water bodies in forest areas with significant variance of biological diversity from the historic range of variability (Montreal Process indicator)

Data are not currently available for this indicator.

9.2.6 Percent of water bodies in forest areas with significant variation from the historic range of variability in pH, dissolved oxygen, levels of chemicals (electrical conductivity), sedimentation, or temperature change (Montreal Process indicator)

There are two on-going long-term regional studies on this issue in Catamaran Brook, New Brunswick, and the Pockwock Watershed in Nova Scotia. Nova Scotia data are not yet available.

10. Forest Ecosystem Contributions to Global Ecological Cycles

Forests contribute to and regulate two global biological cycles: the carbon cycle and the hydrological cycle. They absorb and release carbon dioxide throughout their life cycles through photosynthesis, respiration, and decomposition. Forests also cycle water through the process of evapotranspiration, as well as recycling water, storing water, and regulating water flow. There is little available information on the changing capacity of Nova Scotia forests' contribution to hydrological cycles and to all aspects of the carbon cycle. This chapter therefore deals only with carbon storage, which is one key aspect of the carbon cycle. Future updates of this report should include forest ecosystem contributions to hydrological cycling, as well as a full carbon account for the forestry sector.

10.1 Climate Regulation & Global Warming

The world's forests currently hold some 1,200 gigatonnes (1 gigatonne = 1 billion tonnes) of carbon in their plants and soils, with temperate forests holding about one-seventh of the world's carbon stocks (Myers 1997, Dixon et al. 1994). By storing carbon in living biomass, soil, and forest floor debris, forest ecosystems play a significant role in stabilizing the global climate system, a value that must be considered in estimates of forest values. The value of carbon storage is vitally important today, given the increasing amount of carbon dioxide (the major greenhouse gas) emissions due to fossil fuel burning, and Canada's recent international commitments at Marrakech to implement the 1997 Kyoto Accord reducing greenhouse gas emissions.

Scientists have observed that natural carbon systems are in a balance, and that this balance has been upset by sharp increases in atmospheric CO_2 levels in the last 100 years, which in turn may dangerously warm the earth's temperatures. Scientists have also questioned whether biomass and soils can increase their carbon sequestration sufficiently to absorb the increased levels human-induced greenhouse gas emissions of the last 100 years. According to the authoritative Intergovernmental Panel on Climate Change:

> *"Emissions of CO_2 due to fossil fuel burning are virtually certain*[72] *to be the dominant influence on the trends in atmospheric CO_2 concentrations during the 21st century.*
>
> *"As the CO_2 concentration of the atmosphere increases, ocean and land will take up a decreasing fraction of anthropogenic CO_2 emissions. The net effect of land and ocean climate feedbacks as indicated by models is to further increase projected atmospheric CO_2 concentrations, by reducing both the ocean and land uptake of CO_2"* (IPCC 2001).[73]

Given this evidence, and the fact that the newly agreed rules for implementing the 1997 Kyoto Accord include credits for forest carbon storage, it is especially important to maintain our natural carbon storage capacity. This has direct economic implications. The degree to which forests can successfully store carbon may reduce the extent to which some forms of economic production may have to be curtailed to meet the agreed targets.

Forest carbon budget models include the carbon stored in forests, losses based on the wood product derived, and the fossil fuel used in forest harvesting, management, and production. Although forest biomass is a key component in the world's carbon cycling, a full carbon budget has not yet been released for Nova Scotia's forests, though modelers have estimated that Canadian forests as a whole have become net carbon emitters rather than sinks (Kurz and Apps, cited in CCFM 1997).

GPI Atlantic has asked the Canadian Forest Service to apply the Kurz and Apps model to Nova Scotia, but has been informed that an official request is required from the NSDNR. In the meantime, it is possible to draw some inferences for Nova Scotia from scientific research on the stocks and flows of carbon in forests. These will need to be confirmed through modeling and actual testing.

A New Brunswick study, for example, suggests that a landscape managed for spruce plantations on a 60-year rotation would only store approximately 22% of the above-ground carbon stored in older-growth natural forest (e.g. live trees, snags, coarse woody debris, and the forest floor; Fleming and Freedman 1998). Another study using simulations of carbon storage also demonstrates that the conversion of old-growth forests to young fast-growing forests results in a loss of carbon storage (Harmon, Ferrell, and Franklin 1990).

From such studies it is possible to infer that the conversion of Nova Scotia's old growth natural forests to young, predominantly even-aged stands could diminish the province's forest carbon storage capacity by up to 80%. As well, Schultze et. al. (2000, below), indicate that such conversions may lead to "massive carbon losses to the atmosphere," thereby contributing

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[72] The IPCC defines "virtually certain" as a greater than 99% chance that a result is true (IPCC 2001).
[73] For more details, please see Walker, S. et. al., *The GPI Greenhouse Gas Accounts for Nova Scotia,* Chapter 2 and Appendix A.

significantly to the build up of atmospheric CO_2. In short, different forest management practices may either ameliorate climate change or contribute to climate change.

Harmon et. al. (1990) found that on-site carbon storage declines after timber cutting. The second growth forest only begins to approach the levels of carbon storage of the original old-growth forest after 200 years. A net flux of CO_2 to the atmosphere results even when the sequestration of carbon in wooden buildings is included in the simulation model. For example, the study estimates that the conversion of 5 million hectares of old-growth forest in western Oregon and Washington State over the past 100 years has added 1.5 billion to 1.8 billion tonnes of carbon to the atmosphere.

In other words, an average of 50,000 hectares per year of old-growth forest converted to young fast-growing forests added 15 million to 18 million tonnes of carbon per year, or 300 to 360 tonnes of carbon per hectare per year. In the absence of direct measurements for Nova Scotia, it would be possible to use these figures to estimate both the loss of carbon storage value by Nova Scotia forests over time, and the contribution of the conversion process in Nova Scotia forests to atmospheric CO_2 build-up and to climate change.

Applied to Nova Scotia's 2.6 million hectares of operable forest land (8.1.1, b, above), virtually all of which has been converted from old-growth forest to younger stands, this could mean that historical changes in Nova Scotia's forest structure may have contributed 780-936 million tonnes of carbon to the atmosphere. Needless to say, Oregon and Washington forests are very different from Nova Scotia forests, and more work is needed to adjust the estimates by Harmon et. al. (1990) for conditions in this region.

Nevertheless, for illustrative purposes only, it worth indicating that the Harmon et. al. (1990) assessments do have major economic implications. (Efforts are made below to arrive at a more accurate economic assessment based on actual changes in the Nova Scotia forest age structure in the last 40 years).

At a very conservative climate change damage cost of $20 per tonne (Section b below), the Harmon estimates mean that the historical conversion of Nova Scotia's old-growth forests to younger stands could cost the world between $15.6 and $18.7 billion in cumulative damage costs due to climate change. Based on an extensive review of the climate change economics literature, the *GPI Greenhouse Gas Accounts* (Walker et. al. 2001) actually use a low-end estimate of $38 per tonne, which would almost double these damage cost estimates.[74]

According to Ken Snow, Manager, Forest Inventory, NSDNR:

[74] It should be noted that these estimates are different and much larger than those in Section 10.1.1 (b) below. That is because the estimate given here, based on Harmon et. al., accounts for the total amount of carbon released to the atmosphere during the historical conversion over a long time span of Nova Scotia's entire operable forest area, from its original, natural old-growth state to its present structure. It should be recalled that 300-year old stands of eastern hemlock were common in the province in the early 1900s, with some in that species growing to 800 years. Section 10.1.1 (b), by contrast, refers to the loss of carbon storage capacity since 1958, when less than 9% of Nova Scotia's forest remained in the over-100 age class.

> *"The new growing forest may take up more carbon annually than does an old growth forest which is in a maintenance stage and does not sink large amounts of carbon compared to younger vigorously growing stands. Until the new stand is established however there is some loss of carbon through decay processes which produce carbon dioxide"* (K. Snow 2001).

However, recent scientific evidence published in *Science*, indicates that this conversion from old-growth to young forests still produces a "massive" net loss of carbon to the atmosphere, even when the carbon uptake of new forests is taken into account:

> *"... [R]eplacing old-growth forest by young Kyoto stands, for example, as part of a Clean Development Mechanism or during harvest of previously unmanaged old-growth forest stands as part of forest management (the latter does not gain credits under the Kyoto protocol), will lead to massive carbon losses to the atmosphere mainly by replacing a large pool with a minute pool of regrowth and by reducing the flux into a permanent pool of soil organic matter. Both effects may override the anticipated aim, namely to increase the terrestrial sink capacity by afforestation and reforestation."* (Schulze et. al. 2000).

The authors explain that huge amounts of carbon are stored in tree trunks and branches, and, most importantly, in the soils. Much of the carbon stored in forest soils for hundreds and even thousands of years is released when the forest is harvested, and newly planted forests would take centuries to store up such a large reservoir again.

The economic costs of climate change are already becoming evident, according to a recent report by Goldsmith and Henderson (1999). They have estimated that economic damages and losses arising from climatic destabilization could cost up to $970 billion globally, based on present optimistic models. Estimates compiled by the Intergovernmental Panel on Climate Change, place damage costs to the U.S. economy alone at $56-140 billion *annually* (1990 US$), while some economists place the damage costs several orders of magnitude higher (IPCC. 1996; Bein and Rintoul 1999).

Goldsmith and Henderson (1999) note that tourism, one of the fastest growing industries in the world, is highly susceptible to the impacts of global warming due to the potential rise in sea levels. Coastal areas are both preferred tourist locations, and also the most susceptible to anticipated changes due to climate change. It has been predicted that heat waves, increasing storm frequency, and flooding of beaches will adversely affect tourist operators.

An increase in extreme weather events is predicted to be a consequence of the climate change that has already begun. Goldsmith and Henderson (1999) report that the number of large natural disasters, including windstorms, drought-related wildfires, and floods, has increased three-fold over the past decade. The last 10 years were also the hottest decade since the beginning of instrumental measurements in the 1860s, and included 7 of the 10 warmest years on record. Property losses due to global climatic natural catastrophes during the 1990s increased in cost from $22 billion in 1992, to $100 billion in 1995 (the highest property losses ever recorded), to $90 billion in 1998. For example, the Quebec ice storm of 1999 alone cost $1.5 billion, and insurers in Canada paid over $2.8 billion in 1998 for claims due to natural disasters (Walker et. al. 2001).

These large increases in natural disasters and property losses are also destabilizing the $2 trillion insurance industry. Insurance companies are large investors in pension funds that account for approximately one third of the capital in world financial markets. According to Leggett (1996) increased losses may endanger the insurance sector, which would in turn create a domino effect on world financial markets as a result of their respective investments.

Most recently, one of the world's largest re-insurance firms, Munich Re (that has been monitoring costs of natural disasters since the 1960s), has estimated that climate change damage could globally cost $US304.2 billion per year (ENS 2001). These costs are derived from information from insurers around the world, including losses due to more frequent tropical cyclones, loss of land as a result of rising sea levels, and damage to fishing stocks, agriculture, and water supplies.

For more details on climate change damage cost estimates, including a discussion of the assumptions underlying these estimates, see the *GPI Greenhouse Gas Accounts for Nova Scotia* (Walker et. al. 2001). That study estimates the global damages resulting from Nova Scotia's annual greenhouse gas emissions at between $760 million and $21 billion (1997$), depending on the assumptions employed. However, in the absence of direct measures for carbon sequestration capacity in the province, that GPI Atlantic study was also unable to construct a full carbon budget for Nova Scotia. In the meantime, as noted above, changing forest carbon sink values in the province can only be inferred from other global estimates.

Pearce (1991) has estimated that temperate forests absorb 1.5 tonnes of carbon per hectare per year, and has determined a conservative economic value of $30 per hectare per year in coastal damage avoided through this carbon sequestration capacity. However, actual costs are guaranteed to be much higher, based on acknowledged omissions in the models on which these costs are based (Bein and Rintoul 1999). Information for tropical forests, for example, shows that the conversion of closed secondary tropical forest to agricultural land or pasture could produce damages of $2000-$3000/ha, and that the conversion of primary forest to agricultural uses could produce costs of approximately $4000-4400/ha (Myers 1997, Brown and Pearce 1994). These estimates include allowances for carbon fixation in the subsequent land use.

Future updates of this study should certainly include estimates of likely climate change damage costs due to forest harvesting, forest clearing, and other disturbance in Nova Scotia, based on full carbon budgets and the best available evidence on comparable forest conditions. Within the framework of the Nova Scotia forest accounts, a loss in carbon sequestration value due to changes in forest cover, type, and age, would appear as a decline in the economic value of the province's forest stock, based on a corresponding physical loss in carbon storage capacity . From the point of view of flows rather than stocks, additional calculations should balance the carbon intake of new forests against the increased fluxes of carbon to the atmosphere due to harvesting and forest soil emissions.

While much more work is clearly needed, including both direct and modelled measurements for Nova Scotia forests over time, the following section attempts some preliminary estimates. From the point of view of *stocks,* the current carbon storage value of provincial forests is estimated based on age class, for which information is available from the forest inventories. From the perspective of *flows,* the potential annual cost of carbon loss from forest ecosystems due to timber harvesting is also estimated based on existing models. While preliminary, these numbers do provide estimates of forest values that are still far beyond and more accurate than current assessments that assign such vital forest ecosystem services an arbitrary zero value.

The headings and sub-headings in Section 10.1 below follow the CCFM and Montreal Process guidelines, and thus indicate that the data provided are only one *part* of a future carbon budget, rather than purporting to *be* a carbon budget. Additional sub-headings indicate other elements of the carbon budget for which data are not currently available.

10.1 Contributions to the Global Carbon Budget

10.1.1 Forest sector carbon budget

a) Nova Scotia's Forest Carbon Sequestration

A United Nations report by the Intergovernmental Panel on Climate Change (IPCC) has produced important evidence that new forests cannot be relied upon as effective carbon sinks (Pearce 1999). The IPCC's scientists say that plans for creating new forests as "carbon sinks" to soak up greenhouse gas emissions will actually fail to reduce atmospheric carbon dioxide levels because of the inevitability of a saturated carbon balance. The scientific reasoning is as follows.

Prior to large-scale industrial development, mature forests were in equilibrium with the atmosphere. Both trees and soils absorbed carbon dioxide from the air, and released carbon dioxide through respiration and the breakdown of plant matter by microorganisms. However, this equilibrium has been disturbed by the increasing levels of atmospheric carbon dioxide due to the burning of fossil fuels. The increases in atmospheric carbon dioxide, in turn, will potentially accelerate plant growth and the accumulation of carbon in forest soils, a process referred to as "carbon dioxide fertilization."

However, until recently, researchers had not been aware of a limit or saturation of carbon dioxide fertilization. Carbon dioxide fertilization is not a one-way street, because there are parallel changes in respiration patterns, or the *release* of carbon dioxide by plants, as they break down the sugars produced through photosynthesis. Scientists have observed that there has been a delay in this response of respiration rates, which are now predicted to increase due to higher global temperatures. In other words, there will be a proportionately higher rate of carbon dioxide release to the atmosphere from growing plants and trees as the climate warms. This is not an isolated observation. Experts from the U.K., South Africa, Sweden, and Germany have all reached similar conclusions (Pearce 1999).

Their conclusions are significant given Canada's commitment to cutting greenhouse gas (GHG) emissions according to the Kyoto Protocol, signed by 160 nations on December 10, 1997, and recently confirmed in negotiations in Bonn and Marrakech. Once ratified, this protocol is a legally binding agreement calling for reductions of aggregate GHG emissions by industrialized countries to 5% below 1990 levels by 2008-2012. Given increases in GHG emissions since 1990, current estimates are that Canada will need to reduce its actual emissions by 25%, by 2010, in order to meet this target and its international obligations.

The complication lies in the issue of the accepted methods of reaching the prescribed targets, and particularly in the role of forest carbon sinks. According to the Kyoto Protocol, Annex I countries (industrialized nations) have several options to meet their target including:

a) reducing emissions in their domestic industries, for example, by replacing fossil fuel combustion with renewable energy sources; and
b) domestic increases in afforestation and reforestation.

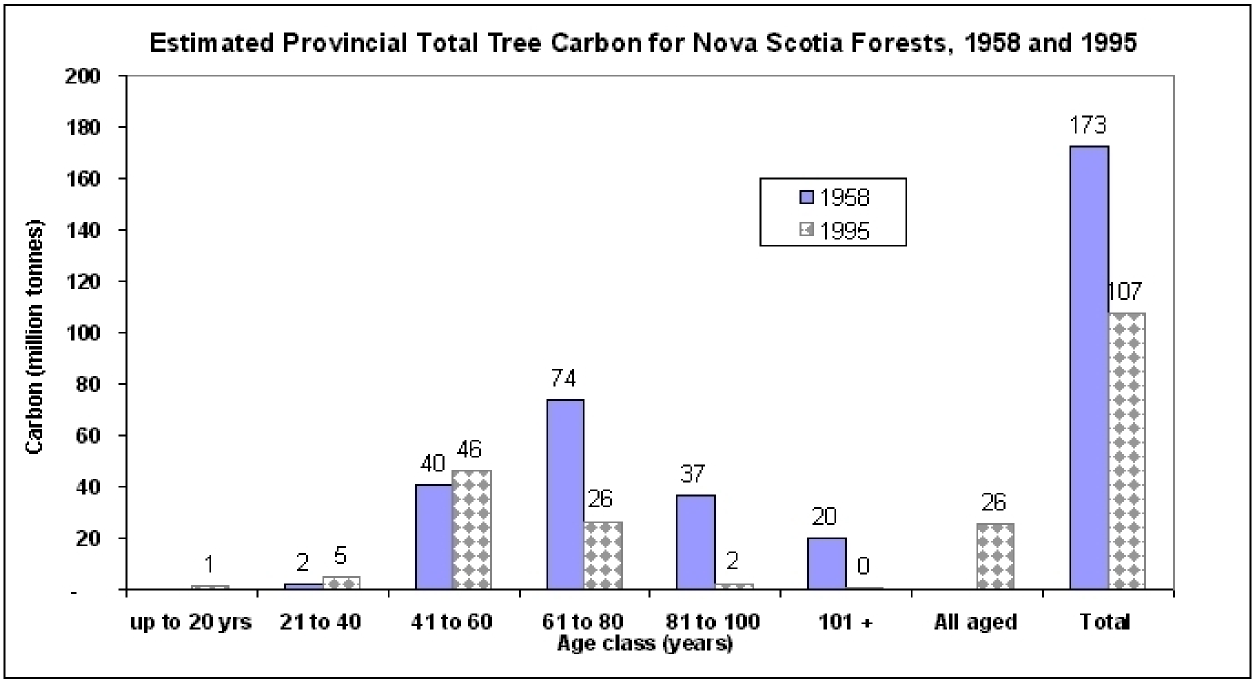
High emitters of greenhouse gases, like the US, Canada and Australia, want to increase reliance on the latter option in order to avoid drastic cuts to GHG emissions and fossil fuel combustion.

However, the IPCC's latest scientific findings cast serious doubt on the latter option as a way of permanently reducing global carbon dioxide levels. The Chair of the International Geosphere-Biosphere Programme emphasizes that planting trees is still a good idea, because of the many other ecological benefits that forests provide. However, he warns that new forests cannot be relied upon to store the ever higher levels of atmospheric carbon that would be the result of continuing carbon dioxide emissions from fossil fuel burning. At the same time, the health and carbon storage capacity of *existing* forests does have a significant effect on potential climate change and on the global carbon budget. The maintenance of *current* carbon storage by forests is, therefore, an important part of the global carbon cycle.

The carbon stored in Nova Scotia forests in 1958 and that stored according to the latest forest inventory is illustrated in Figure 21. Even though younger trees have a more rapid rate of carbon uptake from the atmosphere, larger proportions of carbon are actually stored in the older trees. Therefore, if the age class distribution of provincial forests becomes increasingly skewed towards younger age classes, as is the case in Nova Scotia, the province's carbon storage potential decreases proportionately. This is demonstrated by the change in age class distribution in Nova Scotia's forests from 1958 to 1995. Even though the reported area of forests was less in the 1958 inventory, the carbon stored in tree biomass was significantly greater than that stored in tree biomass in 1995, because there was a higher proportion of older trees.

The average tonnes of carbon per hectare by age class are taken from the latest issue of the CCFM's *Criteria and Indicators of Sustainable Forest Management in Canada: National Status 2000*. As the studies by Schulze et. al. (2000), Harmon et. al. (1990), and Fleming and Freedman (1998) make clear, the loss of old-growth forests and older mature forests in Nova Scotia has certainly produced a significant decline in the carbon storage value of provincial forests.

Figure 21. Estimated Provincial Total Tree Carbon for Nova Scotia Forests, 1958 and 1995



Source: NSDNR 1995 GIS Forest Inventory and Forest Resources of Nova Scotia, 1958; Average tonnes of carbon storage by age class from Kurz & Apps 1999 (see Criteria and Indicators of Sustainable Forest Management in Canada, National Status 2000).

b) Economic Value of Carbon Storage in Nova Scotia Forests

Based on the carbon storage assessments in Figure 21, *the estimated total tree carbon storage in Nova Scotia forests, based on 1995 volume, age, and species composition, is worth $2.2 billion*, However, the carbon stored based on the 1958 forest inventory would be worth $3.5 billion. (Because these are stock estimates, these values are not annualized).

As a result of the change in the age structure of Nova Scotia's forests, there has therefore been a 38% decline in carbon storage capacity, amounting to a loss of 65.3 million tonnes of carbon. The cost of that loss is estimated at $1.3 billion, based on a very conservative global value of $20 per tonne of carbon for climate change damages avoided (Pimentel et. al. 1997). Using the low-end estimate of $38 per tonne, based on the literature review *in The Nova Scotia Greenhouse Gas Accounts for the Genuine Progress Index* (Walker et. al. 2001) the cost of the loss in carbon storage value is $2.5 billion.

Maintaining the age class representation of carbon storage value is important in order to illustrate the economic value of age and natural species diversity described in Chapter 7. The economic loss in value that has occurred due to changes in provincial forest age structure, and particularly due to the almost complete disappearance of the province's old-growth forests, is clear by comparing Figure 1 with Figure 21.

The up to age 20 age class comprises 16% of Nova Scotia's forest area (Figure 1) but contributes only a tiny proportion of the carbon storage value of the province's forests (Figure 21), roughly equivalent to the over-80 age class which comprises only 1% of the province's forests. All younger-aged forests combined (up to age 40) comprise one-third of Nova Scotia's forest area, three times as much as 61-80 year-old forests. But the latter store significantly more carbon than all the younger forests combined. In sum, Nova Scotia’s forests make a considerably smaller contribution to climate stabilization and regulation than they once did.

Future updates of this report should include a species and age-class table comparing percentage of forest area occupied by each class with the corresponding percentage of forest carbon storage value provided by each class. Using the time series in Figure 1, based on forest inventories since 1958, the loss of carbon storage value over time due to conversion from mature uneven-aged, multi-species forests to newly-regenerating forests and even-aged, early successional stands, can be tracked. These estimates can also be used to assess the potential value of investments in restorative forestry, and the financial incentives that could be offered to woodlot owners to conserve the remnant old-growth and few remaining mature forests.

While the above estimates are based on stock values for standing forests, GPI Atlantic has also developed a simple model to estimate cost changes based on the *annual flow* of carbon losses from Nova Scotia forests. The total carbon storage value of Nova Scotia forests is analogous to stock estimates of the total standing timber value in Nova Scotia forests, while carbon loss estimates are analogous to the annual contributions of the forest industry to the provincial GDP based on timber harvests. This distinction between stocks and flows is crucial in the construction of a carbon budget or in any estimate of non-timber forest values.

Due to methodological challenges and additional data needs, GPI Atlantic has decided not to present these carbon loss (flow) estimates in this first iteration of the GPI Forest Accounts, but to hold them until more information is available. Some of these difficulties arose in estimating the amount of carbon that remains in the wood fibre used for products after harvest, which is not lost to the atmosphere (K. Snow 2001). There is considerable potential for including these assessments in a future carbon flow model for Nova Scotia’s forests, as Stinson (1999) demonstrates.

Stinson (1999) extended his own forest carbon model to include forest products, based on the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS) (Kurz et. al. 1992). Stinson (1999) demonstrates that most pulp products are not long-lasting. In his model, 50% of the carbon in pulp products is lost in the first year, 15% remains after five years, and only 10% remains after 10 years. The remaining 10% of forest carbon decomposes more slowly, reflecting the longer life of products such as books, which can last up to 100 years.

Sawlog products are also longer-lasting. In the construction lumber category, 5% of the forest product carbon is lost in the first year due to fitting and shaping, 50% is lost after 60 years, and 95% after 100 years. Other lumber use results in a carbon loss of 40% in the first year due to non-reusable products, 95% after 50 years, and 100% after 100 years. Future forest carbon budget work should include these forest product carbon loss estimates in a simulated computer model.

Needless to say, a full carbon budget would also need to estimate changes in the annual uptake of carbon dioxide by newly regenerating biomass, as well as the loss of carbon through decay processes which produce carbon dioxide while the new stand is still establishing (K. Snow 2001). For all these reasons, *flow* estimates of carbon release and uptake are complex, and have therefore not yet been presented here for Nova Scotia forests. GPI Atlantic would welcome a partnership with scientists interested in further development of a full carbon budget for the province's forests.

10.1.2 Forest sector fossil carbon products emissions

Future work is also necessary on this element of the forest carbon budget for Nova Scotia.

10.1.3 Recycling rate of forest wood products manufactured and used in Nova Scotia

Provincial data are not currently available for this indicator.

As in other sections, the following indicators are briefly described here, despite the lack of Nova Scotia-specific data, in order that these accounts can present and follow the indicator framework of the Canadian Council of Forest Ministers and Montreal Process. They are also included in this first iteration of the GPI Forest Accounts in order to elucidate current data gaps and to suggest areas where important research is required. One of the main goals of this study is precisely to stimulate research that can help fill out these accounts over time so that the full value of Nova Scotia's forests can be assessed.

10.2 Microclimate Regulation

This chapter has focussed on forest ecosystem contributions to the carbon cycle. But forests also contribute to other global ecological cycles that significantly affect climate. One example is the "albedo connection." The sun's heat is the energy that converts surface moisture into water vapour. The energy received depends on the relevant degree of reflectant (shininess) of the earth's surface or cover (i.e. surface albedo). The albedo of vegetation is greater than that of bare soil because it absorbs more heat.

The albedo effect is a major factor in climate control. Thermal currents over thick vegetation take moisture up into the atmosphere where it condenses to rain. When large amounts of vegetation are removed from the earth's surface through clearcutting, deforestation and other practices, lower rainfall and sparser re-establishment of vegetation are often the result (Myers 1997). These factors may influence long-term timber productivity, quality, and economic value. Research and field tests are required in Nova Scotia to assess the degree to which forestry practices over time have impacted the capacity of the province's forests to perform their vital microclimate regulation function effectively.

10.3 Forest Land Conversion

Although not considered here, two key CCFM and Montreal Process indicators that should be included in future updates of this study are the area of forest converted to non-forest land use:

1) permanently, through urbanization and associated uses, and
2) through semi-permanent loss or gain of forest ecosystems through conversions to and from grasslands and agriculture.

Higher rates of conversion from forest to non-forest land use would clearly compromise Nova Scotia's forest ecosystem contributions to global ecological cycles. Within the context of GPI Atlantic's natural resource accounts as a whole, data on forest conversion can assist in land use planning processes, and help identify the best uses of particular types of land so that the province gains maximum long-term value from its land base.

10.4 Forest Sector Energy Use and Carbon Dioxide Conservation

The forest industry's own energy requirements are also considered in the CCFM and Montreal Process guidelines for sustainable forest management as having an impact on the global carbon cycle and on climate change. In Canada as a whole, total energy use in the forest sector has increased by about 13.5% since 1980, but a decreased reliance on fossil fuels has resulted in a 15.1% decline in forest sector CO_2 emissions. Overall, the forest sector is relying more on biofuels (32%), and hydro and nuclear energy sources (38.2%; CCFM 1997).

Specific indicators for Nova Scotia that should be included in future updates of this study therefore include: 1) fossil fuel emissions from the forest sector, and 2) the percentage of forest sector energy usage that comes from renewable sources, relative to the total energy requirement.

10.5 Forest Sector Policy Factors

The CCFM and Montreal Process criteria and indicators also recognize that policy factors, including regulations, data collection, economic incentives, and adherence to international legal commitments all impact the capacity of forest ecosystems to contribute to global ecological cycles.

Future updates of this report should therefore include a fuller consideration and analysis of the following indicators than has been possible here:

1) Existence and type of laws and regulations governing forest land management;
2) Existence of on-going provincial forest inventories and monitoring, with essential information on indicators included in these accounts clearly analyzed, published, and released to the public;
3) Participation in international conventions, such as the Framework Convention on Climate Change and Kyoto Protocol, which can directly impact forest policy;

4) Economic incentives for bioenergy use, selection harvesting, conservation, and other sustainable forest practices.
5) The use of new sustainable forest standards and certification processes, such as the Maritime Regional Standards of the Forest Stewardship Council.

Some of these indicators have been touched on in various parts of this study,[75] but a more systematic analysis of institutional capacity is clearly necessary. This would include an assessment of the functions of the provincial Department of Natural Resources (NSDNR), to determine the degree to which departmental resources effectively protect the province's natural capital assets, and equitably accommodate all sectors of society that have an interest in the health of the province's forests.

So long as assessments of provincial well-being and progress are based on contributions to the GDP and economic growth statistics, for example, it is likely that market interests will dominate departmental functions and priorities. To the degree to which natural capital accounting can be incorporated into measures of provincial well-being, departmental functions are likely to shift accordingly.

It should be noted that the GPI natural resource accounts as a whole follow the basic accounting framework suggested by Dr. Tony Charles in his writings on sustainable fisheries, and therefore include indicators of "institutional" sustainability along with measures of ecological, social, and economic sustainability (Charles et. al. 2001). These institutional factors include the effectiveness of regulatory mechanisms and of stakeholder participation in government decision-making processes. These forest sector policy factors, and the particular role of the provincial Department of Natural Resources as an effective guardian of Nova Scotia's natural wealth, clearly fall within that indicator set and should be included in future updates of this study.

10.6 Contributions to Hydrological Cycles

This chapter has focussed on one global ecological cycle -- the carbon cycle. But forests contribute directly to other vital processes, including the hydrological cycle. While Chapter 9 included some data on long-term changes in water flows in five Nova Scotia rivers, far more work is clearly necessary to link these and other data on changes in water flows in forested areas with the capacity of Nova Scotia's forests to contribute to the global hydrological cycle.

[75] See, for example, the discussion of inventory data in Volume 1, Section 6.3, and the discussion of the new NSDNR silviculture credits in Volume 2, Chapter 10.

PART III

SOCIAL & ECONOMIC BENEFITS OF NOVA SCOTIA FORESTS

11. Multiple Benefits of Forests to Society

Chapter 11 focuses primarily on non-timber benefits of forests. Chapter 12 focuses on timber values of forests. However, this analytical approach does not imply that a choice between these two alternatives is always, or even mostly, necessary. Clearly, there are cases in which complete protection from all logging activity is merited, and an adequate network of protected areas is now accepted as essential to protect biodiversity, wildlife habitat, and other vital ecosystem values.[76]

However, with proper management, much forestland can be successfully managed for multiple resource uses, including timber harvesting. As Chapter 4 of Volume 2 of these accounts, on forest management in the Algonquin Park, clearly demonstrates, good management can reconcile recreation, tourism, and ecosystem values with timber harvesting in a way that enhances the value of all uses. In short, the non-timber benefits of forests in this chapter are not presented as an alternative to timber harvesting, but as a brief catalogue of some of the non-timber values that can be protected and even enhanced by skilful and sensitive harvest and management methods.

11.1 Carbon Storage in Forests

Following the indicator framework of the Canadian Council of Forest Ministers and the Montreal Process produces some repetition, as some evidence belongs in more than one category. The carbon storage value of Nova Scotia's forests has been discussed in some detail in the previous chapter. But the economic value of forest carbon storage capacity in stabilizing climate and avoiding climate change damage costs also constitutes a direct benefit to society.

Strictly speaking, therefore, the economic component of the carbon storage indicator belongs in this chapter. However, in order to link this societal benefit and economic valuation directly with the physical assessments of forest ecosystem contributions to the carbon cycle, the economic assessment has been included in the previous chapter. As noted above, Nova Scotia's forest carbon storage capacity was worth $2.2 billion in 1995.

11.2 Biomass and Nutrient Budget

Soil organic matter, soil nutrients, and minerals are a key part of the "productive capital" of forests and of the timber industry. They are core indicators in GPI Atlantic's natural capital accounts for agriculture, and are subject to depreciation if used unsustainably. Optimal levels of soil organic matter, soil nutrients, and minerals in the "soil bank" enhance productivity are therefore key indicators of "well-being" in the GPI natural capital accounts.[77]

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[76] While international agreements (and Canadian governments) have adopted a 12% set-aside target for protection, conservation biologists generally cite a 30% minimum requirement for adequate protection of biodiversity. See Wilson, J. (2001) for various estimates of this requirement.
[77] These introductory remarks are adapted from Scott, Jennifer, "Are We Making 'Genuine Progress' in Agriculture," *Between the Issues,* Halifax, August, 1999.

Soil organic matter is the dead and decaying plant and animal material that gives soil its spongy texture and distinctive smell, and that performs a wide range of functions essential to plant and timber growth and productivity. It holds water in the soil in dry years and allows it to drain in wet years. It also helps prevent soil erosion, retain nutrients, and reduce soil compaction. It breaks down gradually to provide nutrients for plant growth, thus directly impacting productivity, and it can be built up with additions of plant residues.

Organic matter can also act as a filter, cleaning air and water. It exchanges gases with the atmosphere, acts as a carbon sink, and thus influences global climate. The amount of organic matter in soils depends on the balance between formation and decomposition. For all these reasons, soil organic matter is an excellent overall indicator of soil "health" and productive potential (Scott 1999).

The purpose of any "budget" is to match capital gains and losses with consequent expected service increases or declines. If soil organic matter, nutrients, and minerals are retained, then a forest will be more productive, and provide a wide range of services more effectively, than if these capital assets are depleted. This is not just a theoretical construct, but is borne out by ample field evidence over long periods of time.

Since the 1800s, observers have known that the export of nutrients, associated particularly with the removal of forest litter, has reduced tree growth. Data from intensively managed *Pinus radiata* plantations in Australia and New Zealand have demonstrated that yields decline between first and second rotations (Perry 1998). This decline occurs because of a loss in: a) soil organic matter; and b) nutrients.

Losses in soil organic matter and nutrients result from:

a) the direct removal of harvested biomass (i.e. trees), particularly whole-tree removal;
b) site preparation, including burning, scarification, and piling; and
c) erosion and leaching.

It has already been noted that loss of forest canopy due to clearcutting, road building, and the conversion of primary forests to secondary forests reduces rain interception, increases the impact of rainfall on forest soils, and increases run-off and water flow for a period of 10 to 20 years. These processes can contribute to soil erosion, which in turn leaches and removes vital organic matter and nutrients. Since that process has been discussed earlier, this section focuses on losses in soil organic matter and nutrients through particular harvest and site preparation methods.

Timber cutting techniques are generally dependent on the type of machinery used. Whole-tree removal increases the amount of nutrient loss by 50% to 400% in comparison to tree-length removal (Freedman et. al. 1986, Smith et. al. 1986). Scarification or windrowing are site preparation techniques used to prepare sites for conifer regeneration. This type of site preparation compacts soils and removes large amounts of soil organic matter and nutrients. Morris et. al. (1983) estimated that windrowing resulted in nutrient losses equal to six tree-length harvests of timber from a site.

The implications for longer-term soil fertility and tree growth of losses in soil organic matter and nutrients due to forestry operations are not straightforward. Conifers have the capacity to renew soil fertility. Bacteria associated with conifer rhizospheres and mycorrhizal fungi can fix atmospheric nitrogen and accelerate rock weathering. However, some forest management methods can disrupt such biologically-driven fertility renewal. For example, Hutten (1998) found that nitrogen fixation in Ponderosa pine rhizospheres is lowered in both clearcuts and patch cuts compared to uncut controls.

According to Amaranthus et. al. (1990), nitrogen fixation associated with conifer mycorrhizae is stimulated by the proximity to certain hardwoods. Although this study was done in British Columbia, it suggests that vegetation control, generally through herbicide applications, can reduce conifer-associated nitrogen fixation following timber cutting and post-cutting forest management practices. The study also indicates another potential economic benefit of the natural species diversity of Acadian forests, with naturally mixed hardwood-softwood forests not only increasing forest resilience and resistance to insect infestation, as described earlier, but also improving soil quality and providing nutrients that increase fertility, productivity, and therefore timber values.

Predicting long-term impacts on soil fertility is further complicated by the fact that many conifer seedlings often grow better on intensively prepared sites, compared to sites that are not intensively prepared. This occurs because many conifer seeds need exposed mineral soil to establish, and because tree growth can be enhanced with reduced competition from herbs and grasses. However, evidence indicates that this initial growth spurt may be a transitory phenomenon with adverse long-term effects.

For example, as established plantations reach crown closure, there is extensive evidence of poor growth on intensively managed sites due to poor soil fertility. Because nutrients are concentrated in the foliage in the crown of the tree, whole-tree harvesting, which removes the crown from the site, results in a major export of nutrients. Calcium, on the other hand, is concentrated in the bark of the tree bole. Thus, the greatest net loss in nutrients due to whole-tree or tree-length timber cutting is in calcium.

In Acadian forests, Freedman et al. (1986) found that whole-tree harvests result in a 50% greater removal of biomass compared to tree-length harvests. However, an even greater proportion of some nutrients is removed. In comparison with tree-length harvest, the following losses of nutrients occur in whole-tree harvesting:

- Nitrogen 170% as much nitrogen is lost.
- Phosphorus 200% as much phosphorus.
- Potassium 160% as much potassium.
- Calcium 100% = twice as much calcium.
- Magnesium 120% as much magnesium.

In other words, the immediate short-term economic benefit of greater biomass removal (50% gain over tree-length removal) is more than offset by the higher proportionate loss (100%-200%) in soil nutrients, which will produce longer-term and ongoing economic losses in value.

Data were not available regarding the relative proportions of whole-tree harvesting and tree-length harvesting in Nova Scotia.[78] This is necessary in order to construct an accurate account of nutrient budget changes in soils under forest management. In addition, information is also required on potential nutrient renewal following harvesting, and on nutrient losses due both to post-harvest site preparation, and to erosion and leaching. As such information becomes available, it is highly recommended that a nutrient budget be included in future updates of this report.

Given the fact that Nova Scotia's forests have been degraded due to a history of land clearing and poor forestry practices, it is especially important to monitor the soil's productivity and to conduct appropriate soil tests that will allow the construction of such a nutrient budget in the future. This is essential for the most practical reasons -- a decline in soil organic matter and nutrients may adversely impact future forest productivity in the province and undermine a wide range of forest values, including wood supply. Put simply, we need to know whether this organic matter and nutrient decline is happening and, if so, how significant it is.

Despite the current lack of good information on this important indicator, enough is known from the scientific literature to make one key recommendation that can be implemented without delay. Since a 50% greater yield in harvested biomass produces a disproportionately larger loss in vital nutrients, whole-tree harvesting literally depletes capital stocks at a greater rate than current flows are being increased. That is simply bad economics, as diminishing capital stock will impair its capability of providing future flows of goods and services. Thus, it is important to set regulations that enforce better management practices and discourage whole-tree harvesting.

Whole-tree harvesting may be compared with fishing above the sustainable catch limit, or to increasing the catch by dragging and removing vital nutrients from the benthic (ocean-bottom) environment. In both cases short-term harvesting gains are at the expense of long-term natural capital depletion that can adversely affect future productivity. It should be noted that not all harvesting in Nova Scotia is whole-tree harvesting, but regulations are required to ensure that best management practices are implemented across the province to minimize nutrient depletion.

11.3 Economic Value of Non-Market Goods and Services

11.3.1 Forest ecological valuation

In the Foreword and Appendix C, the limitations of monetized valuations of ecosystem services are discussed in some detail. Money is acknowledged as generally a poor tool to describe non-market values. However, it is also recognized that monetary valuations are temporarily and strategically necessary, because market considerations currently dominate the policy agenda, and non-monetary

[78] Peter MacQuarrie, NSDNR, notes: “It is my impression that interest in whole tree logging waned with the end of the original 'energy crisis.' The logging equipment that was acquired has not been retained or replaced. Even tree length logging is less common. Our logging 'fleets' are now geared towards cut-to-length processors at the stump to maximize sawlog recovery. Low ground pressure tire equipped machinery is common” (P. MacQuarrie. pers. comm. 2001).

assessments therefore command insufficient attention in the policy arena. The following valuations should be considered with these limitations in mind.

Using replacement value and contingent valuation methods,[79] Costanza et. al. (1997) estimated that the value of the world's ecosystem services are worth at least US$33 trillion (1994$) per year. This amount represents almost twice the global gross national product (GNP) of approximately US$18 trillion (1994$) per year.

As part of this massive ecosystem contribution to human society, temperate and boreal forest ecosystems are estimated to contribute a flow of services worth US$894 billion per year (1994$). This is equal to 2.7% of the total value of global ecosystem services estimated by Costanza and his associates, or 5% of the value of the world's human economy. This estimate is based on climate regulation, soil formation, waste treatment, biological control, food production, raw materials, recreation and cultural goods and services.

The estimates by Costanza and his associates are conservative, and exclude many other essential ecosystem services only because of a lack of data and information sources, including gas regulation, disturbance regulation, water supply, soil erosion control, nutrient cycling, pollination, habitat, and genetic resources. Some critics have argued that the estimates of Costanza et. al. (1997) estimate are actually a vast underestimate, understating ecological service values by several orders of magnitude (P. Bein pers. comm. 2000).

Counting only the ecosystem services considered by Costanza and his associates (1997), temperate and boreal forests contribute at least US$302/hectare/year (1994$), or CAD$430.10/ha/year (1997$) in ecosystem services. Although these calculations were not explicitly designed to be extrapolated for environmental valuation purposes at the regional level, the benefits valued in these assessments are nevertheless indicative of the values and the vital information missing from conventional resource accounting systems.

Until there is adequate information on the wide range of non-market forest values at the provincial level, and until there are consistent data measured and monitored on a regular basis to value Nova Scotia's forest goods and services fully, the assessments and methods used by Costanza et. al. (1997) can provide a temporary valuation substitute.

Also, as noted in the preface, data limitations did not permit an aggregation of the value of forest services to arrive at a composite estimate of the full value of Nova Scotia’s forests. Wherever possible, the economic benefits of various forest functions have been described, such as in the carbon storage section of the previous chapter, but these various economic benefits have not been summed to any cumulative total. The estimate adapted from Costanza et. al. (1997) below (Table 9) *is* a partial aggregation of the value of some forest ecosystem services. However, this is

[79] It must be acknowledged that contingent valuation methods (assessing consumers’ willingness to pay for services that may not be traded in the market) is very controversial. Issues of subjectivity, the gap between expressed intentions and real actions, and difficulties in scaling responses are some of the problems (P. Woolaver 2001). Nevertheless, it is argued by proponents of these methods that, despite their acknowledged shortcomings, they are still more accurate in recognizing and attempting to assess the real value of ecosystem and other non-market services than are conventional accounting systems that implicitly assign these vital services an arbitrary value of zero.

presented here as a stand-alone extrapolation, and should not be understood as additional to any direct valuation for Nova Scotia's forests presented elsewhere in these accounts.

For example, Costanza's climate regulation function would include carbon sequestration, which was dealt with separately in the last chapter, and the $534 million annual flow benefit listed in Table 9 should not be confused with or added to the $2.2 billion carbon storage stock estimate in the previous chapter.

With all these caveats, the monetary value of forest ecosystem services assessed by Costanza et. al. (1997) is applied to Nova Scotia's forests, using the benefits transfer method, simply by multiplying the estimated per hectare economic benefits by the total area of forestland in the province (Table 9). For the reasons noted above, the estimates in Table 9 should not be taken as literal values for Nova Scotia forests, but are given to demonstrate how vast, extensive and valuable forests goods and services are to the province.

Table 9. Valuation of Nova Scotia's Non-Timber Forest Ecosystem Goods and Services

Ecosystem Service	**Monetary Value (1997$/ha/year)**	**Total Flow Value for Nova Scotia (1997$millions/ year* total forest[80])**
Climate regulation	$126.20	$534.0
Soil formation	$14.34	$60.7
Waste treatment	$124.77	$528.0
Biological control	$5.74	$24.3
Food production	$71.71	$303.4
Recreation	$51.63	$218.5
Cultural	$2.87	$12.1
Total (not including raw materials)	$397.25	$1,681.0

*Monetary value estimates are based on replacement values and contingent valuations. Conversion of USD to CAD is based on the inter-bank rate average for 1994 (1.36581). Source: Costanza et. al. 1997.

Extrapolating from the global estimates of Costanza et. al., the province's forests could therefore be assessed as contributing $1.68 billion per year (1997$CAD) in non-timber ecosystem goods and services to human society.

As noted above, this estimate is for the following goods and services only: climate regulation, soil formation, waste treatment, biological control, food production, recreation, and cultural goods and services. Raw materials (timber) are not included in this estimate. Other essential services provided by forests that are not included in this estimate due both to lack of data and calculation difficulties are: water supply and regulation (watershed protection), soil erosion control and sedimentation retention, nutrient cycling, and the conservation of pools of biological diversity. If these and other ecosystem functions were included in the estimate, the economic value of forest ecosystem functions in Nova Scotia could be double the estimate given above, exceeding $3 billion annually.

[80] Total provincial forest is 4,231,570 ha. Provincial forest area data are from the February 1999 DNR GIS Forest Inventory.

A proper regional valuation would need to examine each of the assumptions in Costanza et. al. carefully, and to make the appropriate adjustments. Resources did not allow such an analysis for this study. But it might be speculated, for example, that the food production value of Nova Scotia's forests would be less than that of tropical forests, which produce abundant edible fruits and nuts, requiring the Costanza values to be adjusted downward for that measurement. Other assessments might be adjusted upwards, depending on a careful analysis of forest structure, type and conditions. Nevertheless, the omission of several vital ecosystem functions of particular importance to Nova Scotia (such as watershed protection) make it likely that the aggregate estimate in Table 9 is still conservative.[81]

There are many other methodological issues raised by such valuations. While the Costanza estimates are averages, and thus take into account different productive capacities of different forest segments, a more careful analysis would consider the different marginal values of different forest areas. For example, one particular hectare may have a very high recreational value, while another may have a minimal recreational value.

Further, a careful provincial analysis would also consider the *comparative* ecosystem values of Nova Scotia forests over time. In other words, if the $1.68 billion estimate given above represents the current value of forest ecosystem functions in the province, what would these services have been worth 40 years ago or 100 years ago when our forests had a very different age and species structure. To answer this question, the assumptions of Costanza's scientific team would have to be closely analyzed to assess the quality, structure and composition of the forests to which each estimate applies. Clearly a degraded forest provides less ecosystem services than a healthy forest. Again, this study simply uses the final results of the Costanza team without adjusting the estimates for the quality of the forests at a particular point in history.

A more serious criticism of monetary valuation altogether is that it implicitly assumes the substitutability of ecosystem services, when in fact many such services are irreplaceable and thus "invaluable." As noted both in these accounts, and in the GPI framework as a whole, GPI Atlantic completely acknowledges that money is a very poor tool to value non-market services altogether. However, current policy frameworks are so dominated by market considerations and budgetary constraints that lack of valuation has resulted in an implicit *devaluation* of non-market services, and a de-linking of human well-being from its environmental roots.

For strategic reasons, therefore, in order to acknowledge and recognize the vital importance of these hidden values, GPI Atlantic recognizes that monetary valuations are temporarily necessary. Even approximate estimates of the value of ecosystem functions are an essential antidote to their current zero valuation in the conventional accounts. Ideally, and hopefully eventually, the conservation of vital ecosystem functions will be a priority in its own right, with physical assessments of ecosystem functions sufficient to prompt policy makers to value environmental quality and natural resource health equally with market and social values.

It should also be noted that Costanza and his colleagues set out explicitly to value ecosystem functions. But this does not mean that timber and non-timber are mutually exclusive. A well-

[81] For example, Peter Bein, Environment Canada (pers. comm. 2000), indicates that Costanza's assumptions are highly conservative, and that a more accurate valuation would assess ecosystem services very much higher.

managed forest can provide wood fibre and still protect and even enhance the full range of ecosystem services valued by Costanza's team of scientists.

The estimates of Costanza et. al. (1997) are based on replacement value and contingent valuation estimates derived for temperate forest ecosystems. Replacement values can include the costs of human engineering construction to replace lost equivalent ecosystem services, such as the cost of a water filtration plant that replaces functions once performed by a healthy forested watershed. Contingent valuations include estimates of what individuals are willing to pay beyond what they may already contribute in market expenditures, to ensure ecosystem services continue, or to ensure that wilderness is protected. For example, surveys on how much national park visitors are willing to pay beyond their entrance fee, can be used in assessments of forest values to reflect the non-market value of an experience and/or the non-use value of wilderness.

Specifically, Costanza et. al. (1997) used the following priority order to assess proxies for the economic value of ecosystem values, representing declining levels of methodological rigour: 1) the sum of consumer and producer surplus; or 2) the net rent or producer surplus; or 3) price times quantity, with preference being given to the first of these whenever possible.

Section 10.1 above does attempt to take preliminary steps towards a forest tree carbon budget based on specific Nova Scotia provincial data. Funding and data limitations did not allow the development of full carbon and nutrient budgets for Nova Scotia's forests in this study. However GPI Atlantic strongly recommends that these and other direct valuations of Nova Scotia forest services be included in future updates of this study. In that way, direct physical accounts as well as more accurate measurements of the costs and benefits of particular forest management methods can gradually be substituted for the present extrapolations based on Costanza and his associates.

As noted above, the global estimates of ecosystem service values by Costanza et. al. (1997) have been compared to estimates of human economic activity as expressed by gross world product, with total ecosystem services estimated at about twice the value of total economic output. While recognizing that such comparisons are fraught with methodological difficulties, it can simply be noted here for comparative purposes that the estimated non-market forest values for Nova Scotia (as outlined in Table 9 above), amount to about 9% of the province's GDP.[82] This is equivalent to nearly four times the contribution of timber alone (2.4% of GDP in 1999). The contribution of forestry industries (logging and forestry services), wood industries, and pulp and paper industries to the provincial GDP at factor cost[83] was approximately $422 million ($1997) in 1999.[84] The

[82] Peter MacQuarrie, NSDNR, (pers. comm. 2001) and Peter Woolaver, NSDNR, correctly note, for example, that contingent valuation or willingness to pay estimates should be compared with market values or shipments in the industrial sector rather than with GDP. Here the authors are simply following the comparisons of Costanza and his team of scientists in comparing the value of ecosystem services to gross world product. A more careful analysis is required to examine the assumptions underlying these comparisons.

[83] GDP at factor cost is GDP at market price minus subsidies minus indirect taxes; Selected Forestry Statistics, CFS, 1993.

[84] GDP statistics from Statistics Canada, *CANSIM II* Database, Table 379-0003, GDP at factor cost by Standard Industrial Classification (SIC).

higher ratio of Nova Scotia's forest ecosystem services to economic output (9%) compared to the global ratio (5%) demonstrates the particular importance of forests to this province.

The recreation value of Nova Scotia forests is estimated at $218.5 million annually [using Costanza et. al. (1997) calculations], demonstrating the importance of non-timber use of the province's forests for ecotourism. This estimate, extrapolated from Costanza's global estimates, is similar to the Nova Scotia-specific data presented below, which show $250 million in expenditures on nature and wildlife in Nova Scotia in 1996 (Table 9), and $90.5 million in aggregate expenditures associated with the use of tourist and hiking trails in the province (Section 11.6).

As Volume 2, Chapter 4, demonstrates, these recreational and other non-timber values on the one hand, and timber values on the other, are not mutually exclusive in well-managed forests. In Nova Scotia, however, the accelerated rates of clearcutting that have occurred in the 1990s, with the continued losses in old-growth and mature forests and in associated wildlife habitat, make the province's forests less attractive to tourists and may undermine a key asset of the burgeoning billion dollar tourism industry in the province.

Direct employment, revenues and contribution to GDP from the growing tourism industry are comparable to direct employment, revenues and GDP contribution in the timber industry (see Chapter 12). Clearly these are two major Nova Scotia industries of comparable importance to the provincial economy, which are both resource-dependent and which share a need for sustainable management of the province's forest resources.

At a minimum, these comparisons demonstrate that existing timber accounts, which assess forest values based on one limited criterion, are inadequate. In order to maximize a sustainable flow of forest-based goods and services, the loss in values following timber cutting, due to the decline in other forest ecosystem functions, must be considered. In such an accounting system, as proposed in the GPI, the contribution of the timber industry to Nova Scotia's GDP would then be assessed as a *net* gain or loss to the economy depending on the degree to which other forest values are maintained or depleted.

Fully capturing the status of the province's forests in this way will enhance decision-making capabilities that link provincial employment and economic well-being with a sustainable future for the province's natural areas. Similarly, restorative forest practices that enhance forest values by restoring the uneven-aged structure and species composition of the Acadian forest, improving soil quality, and restoring carbon storage capacity and the protection of watersheds in areas where these functions have previously been depleted, should be regarded as *investments* in natural capital.

Therefore, at the policy level these monetary comparisons demonstrate the necessity for employing timber harvest practices that protect the full range of forest values. In addition, such a comprehensive approach depicts the expediency and cost-effectiveness of offering financial incentives to woodlot owners and industries that protect those extensive values. Practically speaking, the physical accounts and economic valuations of non-timber forest values present a case for reducing woodlot land taxes in proportion to the extent to which ecosystem-based selection harvesting is used to maintain or restore Acadian forest types, and to maintain forest functions, services, and values. In the case of clearcut harvesting, which is generally not an ecologically appropriate method in the Acadian forest, woodlot land taxes should include the damage costs incurred.

At a deeper level, comparisons amongst different forest interests also provoke an analysis of the links between them. For example, the conservation of forest ecosystem functions through low-impact best forestry practices can enhance long-term timber values. Rather than the trade-off between the conservation of ecosystem values on the one hand and economic timber values on the other that is conventionally assumed, therefore, a win-win situation can be demonstrated through such linked economic valuations.

Indeed, one of the major goals of the GPI accounts is to illustrate the inherent links between sustaining ecological well-being (e.g. our natural assets, and life-sustaining goods and services), and the sustainability of communities and economies. In this way, economic valuations of ecosystem services can help to break down the artificial distinction between environmental, social, and economic interests.

Estimates of the monetized value of forest ecosystem services can also be considered in conjunction with services performed by other natural capital assets in the province. Beyond these particular forest accounts, such linkages can demonstrate the vital importance of expanded physical accounts and the need for internalizing externalized environmental costs as a whole in order to protect ecological, social, and economic well-being in Nova Scotia.

For example, using the estimates in Costanza et. al. (1997), Nova Scotia's wetlands contribute CAD $1.85 billion ($1997) per year ($21,200/ha/year), and the province's lakes and rivers contribute CAD $3.08 billion ($1997) per year ($12,190/ha/year) in ecosystem services to Nova Scotia society.[85]

Like the forest estimate, these river and wetland estimates also do not account for all the goods and services provided by rich sources of natural wealth in the province. Nevertheless, the quantifiable services provided by these three sets of natural capital assets alone (forests, wetlands, and rivers and lakes), contribute a total economic value equivalent to one-third of Nova Scotia's 1998 GDP.[86] As noted above, Costanza et. al. (1997) estimate that the ecosystem services provided by the world's natural capital assets, including oceans and agricultural soils, have an annual economic value equal to almost twice that of the global GDP.

No claim is made for the precision or comprehensiveness of these estimates, and they are universally acknowledged to err on the side of conservatism. Nevertheless such monetized estimates are useful as an interim strategy to encourage concerted efforts towards improved natural physical accounting at the provincial and national level, including the internalizing of costs through full-cost accounting mechanisms.

[85] The same caveats noted for Costanza's forest ecosystem valuations apply to these valuations for wetlands, rivers and lakes, particularly the need to make adjustments for regional conditions.
[86] $6.61 billion (1997$) is 35% of Nova Scotia's 1998 GDP at factor cost ($19.19 billion in 1997$).

However imprecise current monetized estimates of ecosystem services may be, assigning economic values to non-timber forest functions still provides a far more accurate assessment of forest value than existing conventional accounting mechanisms that in effect assign an arbitrary value of zero to these non-market services.

At a minimum, these estimates acknowledge the vital contribution of these forest functions to economic and social well-being, and show that we neglect forest non-timber values at our peril. If natural asset depletion and a decline in ecosystem services remain invisible in our assessments of wealth and in our economic accounting mechanisms, we will very likely leave future generations fewer resources and resources of lower quality.

This study demonstrates that losses in the natural diversity, composition, and structure of Acadian forests, including losses of old forests, valuable species, canopy height, carbon storage capacity, and wildlife habitat, have already resulted in poorer quality forests. The study also refers to linkages between these losses and potential declines in soil quality, nutrient and organic matter content, and freshwater fish populations. In economic terms, Nova Scotia forests are worth "less" now than they were historically.

If capital assets are to remain healthy, and maintain their natural and potential value, Nova Scotians have to live off the annual interest these assets provide rather than by consuming the wealth itself. In conventional accounting systems, increased harvest levels can temporarily mask losses in natural wealth, because ecosystem values are ignored. This is identical to the illusion of maintaining a high standard of living that masks an accumulation of consumer debt. Sooner or later, the growing size of that debt compromises the economic viability of the enterprise as a whole.

Just as this generation is paying for prior spending excesses and debt accumulation with reduced health care services and higher tuition fees, so future generations will pay the price of a continued decline in forest values and of ever higher carbon, nutrient, and biodiversity debts. Conversely, if the concept of "budgeting" is literally applied to all our social, natural and economic capital assets, then the value of restorative investments, such as employing harvest methods that conserve natural wealth for the benefit of current and future generations, become evident.

11.4 Economic Value of Protected and Natural Areas

11.4.1 Biodiversity and habitat

Non-use values can be measured by economists using assessments of individuals' "willingness to pay" to conserve biodiversity and other values. Approaches commonly used include contingent valuation method (CVM), travel cost, and hedonic property price. These methods are controversial primarily because they value specific assets rather than an ecosystem as a whole, and thus they may miss critical linkages and dependent relationships. They have also been challenged because of the difficulty of scaling responses, the difference between intentions and actions, and the frequently subjective nature of the survey instruments (P. Woolaver, 2001). Nevertheless, many ecological economists argue that contingent valuation measurements are still far more accurate in at least recognizing the non-market value of nature's services than assigning these services an arbitrary value of zero, as conventional accounting mechanisms imply.

Adamowicz et. al. (1996) have compiled results from research that has utilized these new approaches for the evaluation of biodiversity to estimate that citizens of rich countries are willing to pay $10 per person per year to conserve biodiversity (Appendix A).[87] This contribution would produce a biodiversity protection fund of $4 billion from Europe and North America alone, about four times the current fund of the United Nations Global Environment Facility. Using this estimate, and assuming that Nova Scotians value biodiversity conservation to the same degree and with the same intensity as other citizens with comparable living standards, Nova Scotia residents may place a value of $9.4 million/year on biodiversity conservation**,** based on the province's population (940,825 in July 1999).[88]

While this estimate is based on expressed willingness to pay, other studies have examined the values Nova Scotians place on nature and wildlife by chronicling their *actual* expenditures. According to an Environment Canada survey, 326,000 Nova Scotia residents (44% of the provincial population) participated in outdoor activities in natural areas in 1996, spending 5.6 million days or an average of 17.1 days per participant per year in the outdoors. 130,000 residents (17.6%) spent 2.5 million days viewing wildlife in the same year. As a result, total expenditures on nature-related activities have increased more than 50% since the 1970s, from $165.1 million in 1970 to $249.7 million in 1996 ($265 per person) (Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians. 2000).

Aside from its recreational value, wildlife also provides ecological services of immense economic value to human society. Decker and Goff (1987) remark that wildlife plays a vital ecological role in pollination, seed dispersal, and protection from pests. In addition they emphasize our reliance on invertebrates and micro-organisms for nutrient cycling. For example, the economic benefits of a diverse group of microbes have been evaluated by Pimentel et. al. (1992a, 1992b) who estimate that US$7 billion of nitrogen is annually supplied worldwide by nitrogen-fixing microbes.

11.4.2 Case study: Socioeconomic value of the Pine Marten, a threatened species

Adamowicz and Condon (1997) asked individuals living in Newfoundland to vote on a public trust for the management of the American Marten area. They compared the values obtained through this survey with the value of the softwood lumber in the same region, as estimated in a previous study by Milne (1988). The latter study considered the net social value in annual value added and value generated by the forest industry, and the residual timber value of the lumber price minus harvesting, transportation costs, profit, and risk allowances.

[87] Appendix A is a compilation of published results indicating the willingness to pay to conserve biodiversity, from Adamowicz et al. (1996).
[88] Population estimate from NS Dept. of Finance, Statistics Division www.gov.ns.ca/fiinance/statisti/.

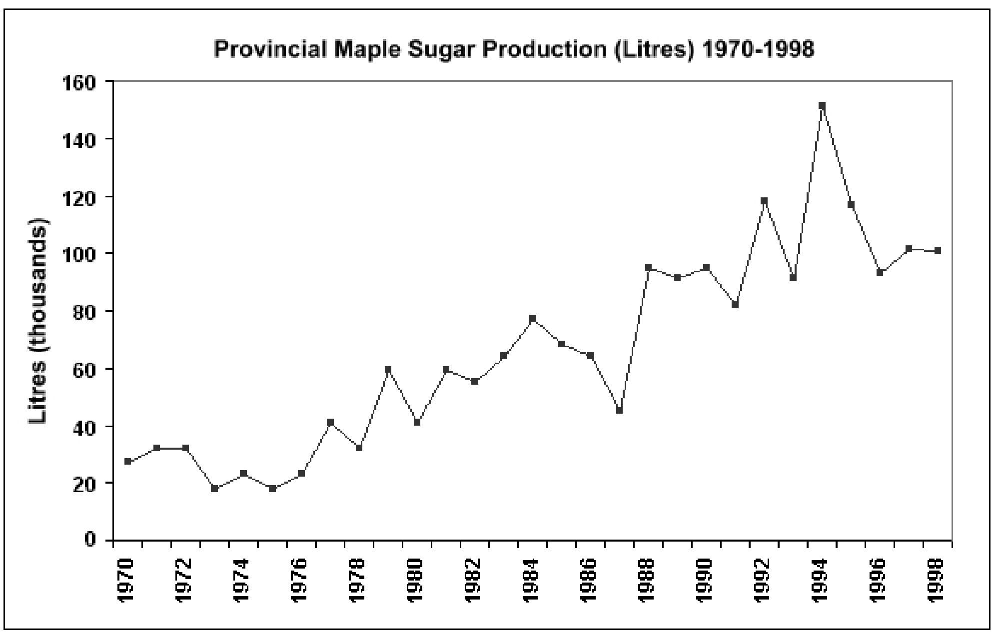
The results of these studies indicated that the benefits of the American Marten and its habitat in Newfoundland are greater than the net social value of timber harvested and also greater than the residual timber value (Appendix A). Adamowicz and Condon (1997) concluded that the aggregated values probably underestimate the benefits of the conservation area, because the benefits outside of Newfoundland are not included.

11.5 Value and Quantities of Production of Non-Wood Forest Products

11.5.1 Maple sugar products

The production of maple sugar products has increased three to four-fold over the past three decades (Figure 22). The wholesale value has similarly increased from about $200,000 ($1997) in l970, to about $900,000 ($1997) in l998 (Figure 23).[89] This amount represents the wholesale value, with retail sales generating much higher values. Despite the dramatic increase in production, and the potential value of coveted sugar maple products in the market place, the volume of sugar maple trees has declined since the 1700s and 1800s across the province. Currently, sugar maples constitute less than 9% of forest cover (NSDNR l991).

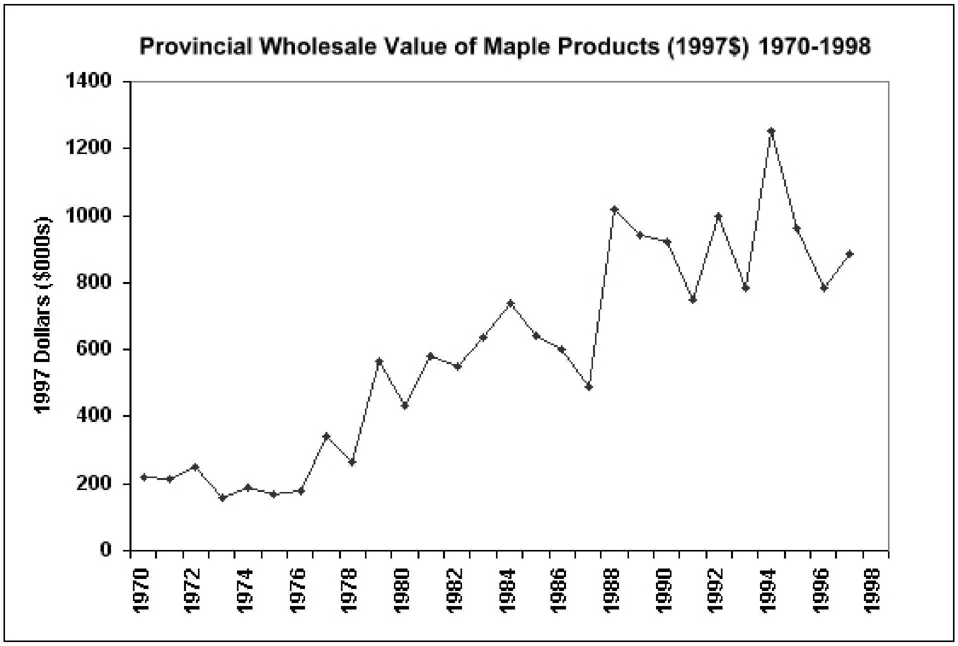
Figure 22. Provincial Maple Sugar Production (Litres) 1970-1998



Source: National Forestry Database.

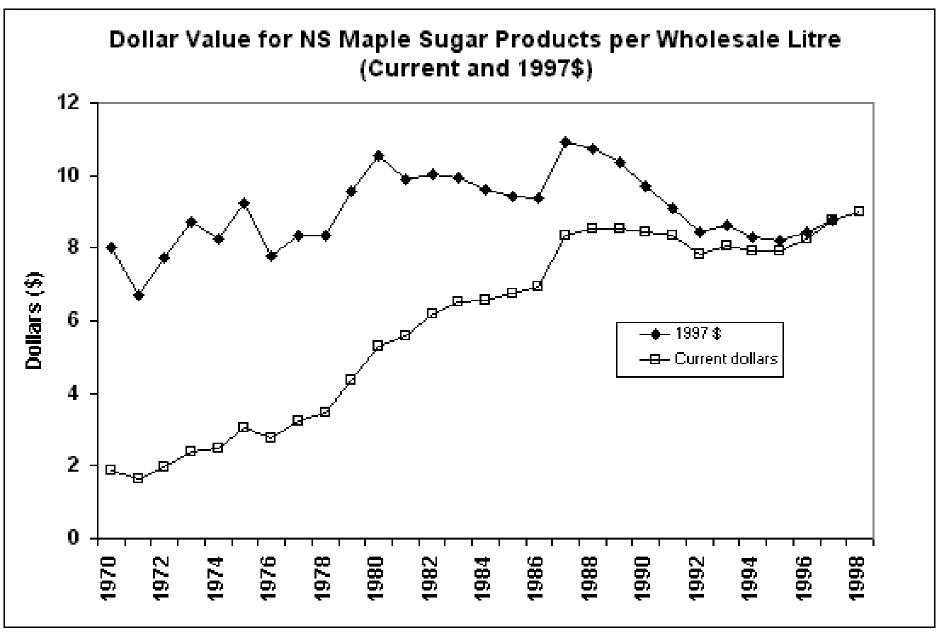
89 At time of publication, the GDP value of sugar maple products had not been ascertained. This wholesale value should not, therefore, be compared to the timber contribution to GDP noted in Chapter 12.

Figure 23. Provincial Wholesale Value of Maple Products (1997$) 1970-1998



Source: National Forestry Database.

Figure 24. Dollar Value for Nova Scotia Maple Sugar Products per Wholesale Litre (Current and 1997$)



Source: National Forestry Database.

A decline over time in shade-tolerant hardwoods can therefore have a direct economic impact on non-timber forest goods such as maple sugar products. Future updates of this report could estimate the foregone revenue (or potential sales) of sugar maple products based on past historical estimates of forest cover. Clear sugar maple production is limited by other factors than species availability, including the fact that production is dependent on hard labour, weather, and business risks that may limit profits.[90] However, the sharp increase in demand, production and sales of the past three decades indicates that production would likely increase with greater species availability. The economic benefits of sugar maple production illustrate the importance of forest harvest techniques that protect the full array of native tree species diversity and stem the decline in shade-tolerant hardwoods.

11.6 Recreation & Tourism[91]

11.6.1 Availability and use of recreational opportunities

It has been noted that a key indicator of forest ecosystem health and forested watershed protection, is fish populations. Total recreational fish caught and fish catch per angler, have both declined since 1975 (Figure 25).[92] This has economic implications. Interestingly, expenditures for recreational fishing in Nova Scotia actually increased quite sharply between 1975 and 1990. Although a decrease occurred between 1990 and 1995, total expenditures in 1995 are still higher than in 1975 when nearly twice as many fish were being caught (Figure 26). This means that recreational anglers are paying more money to catch less fish, or about twice as much per fish in constant dollars as 20 years earlier.

As the cost per fish has increased, it could be said that the average angler's "willingness to pay" has also increased. If this trend continues, however, recreational anglers may determine that it is

[90] P. MacQuarrie, NSDNR, pers. comm. 2001.

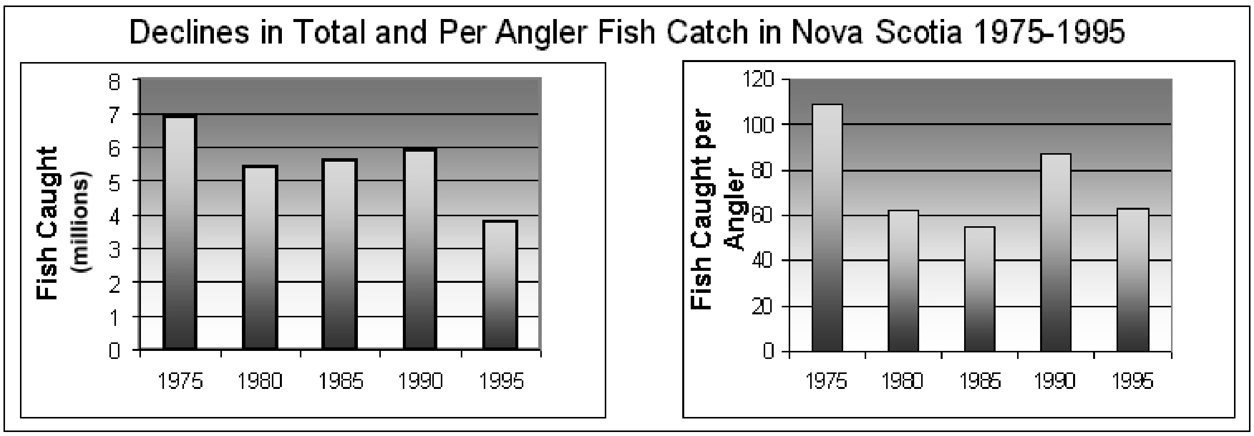
[91] Peter Woolaver and Peter MacQuarrie, NSDNR, correctly point out that this account of the tourism and recreation value of Nova Scotia forests contains no analysis of the ecological impacts of the tourism industry itself, including the nature tourism sector. GPI Atlantic completely acknowledges that critique. Indeed, Chapter 11 of Volume 2 of these accounts notes that all natural resource accounts are inherently limited by their focus on the “supply” side of the sustainability equation, which implicitly puts the onus for sustainability on the harvesters of resources (such as farmers, foresters, fishermen). That final chapter, and the GPI framework as a whole, note that this entire analysis, and the natural resource accounts as a whole, should be read in conjunction with the GPI *Ecological Footprint Analysis for Nova Scotia* (Wilson, J. 2001). The Ecological Footprint assesses sustainability from the demand or consumption side rather than the production side, and thus puts the onus of responsibility for sustainability on consumers as well as producers. From that perspective, the critique offered here applies not only to tourists but to consumers of wood products. Just as appreciation of nature and the growth of ecotourism must be tempered by an analysis of the ecological impact of the industry, so sustainable timber harvest practices must be supported by changes in wood consumption habits. Full-cost accounting analyses of both the tourism and forestry industries from the perspective of the GPI as a whole would include the costs of greenhouse gas emissions, fossil fuel consumption, and other resource consumption and waste production impacts.

[92] Also as noted above (Section 9.2.4), the decline in fish populations is a highly complex phenomenon that is not due to any factor in isolation. Rather, changes in the distribution and abundance of aquatic fauna have been linked to many factors. Acid rain, climate change, over-fishing, sedimentation, and loss of forest canopy cover have all been implicated in salmon and trout population declines in Nova Scotia (Duke 2001b). Because forest practices are a potential contributing factor to changes in aquatic fauna, this indicator is considered in the CCFM and Montreal Process frameworks, and therefore included in this study as well.

too expensive to fish in Nova Scotia, given the steadily declining return on their expenditures which has been continuous over the past 20-year period (Figure 26).

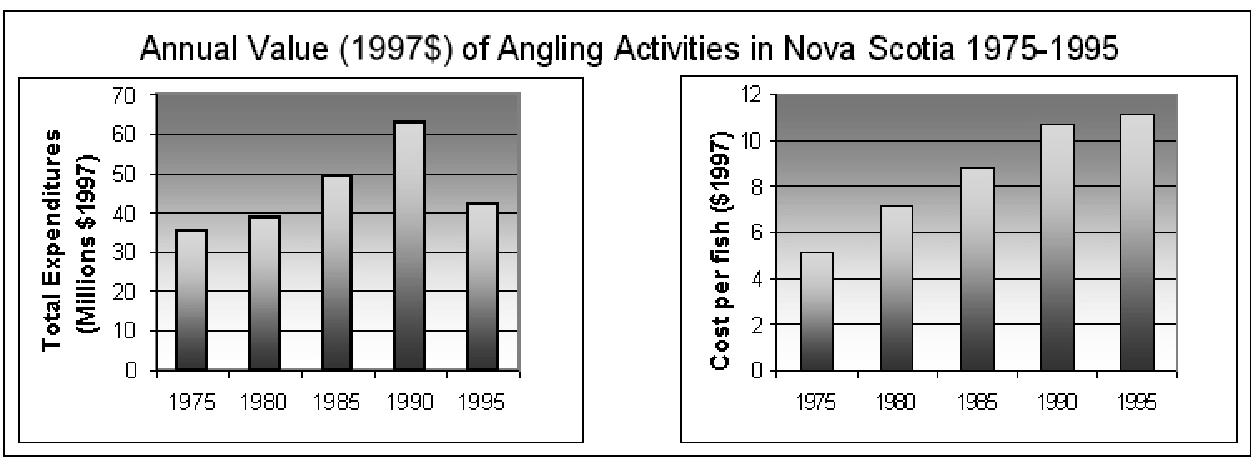
Since recreational fishing is often preferred in streams and rivers located in forested areas, the trends demonstrated in Figures 25 and 26 can clearly have an adverse long-term economic impact on recreational forest opportunities and on tourism revenues. The sharp one-third decline in total recreational fishing expenditures between 1990 and 1995 alone may be the first sign of this downturn.

Figure 25. Declines in Total and Per Angler Fish Catch in Nova Scotia 1975-1995



Source: MacAskill 1999 (Source DFO Recreational Fishing Statistics).

Figure 26. Annual Value (1997$) of Angling Activities in Nova Scotia 1975-1995



Source: MacAskill 1999 (Source DFO Recreational Fishing Statistics).

The protection of non-timber forest values is again shown to have direct economic value, with these trends demonstrating the necessity for assessments of *net* rather than *gross* receipts from timber harvesting and removal of forest cover. While there are clearly many causes for the decline in recreational fish populations (see Section 9.2.4), it is nevertheless noteworthy that the sharp increase in clearcutting in the 1990s (see Section 8.1.1, Figure 15), paralleled the 35% decline in recreational fish catches during the same period.

11.6.2 Total expenditures by individuals on activities related to non-timber use

In 1993, a Wildlife Advisory Council report submitted to the Nova Scotia government forecast an increasing demand for non-consumptive wildlife-related pursuits (DuWors et. al. 1996). A 1996 Environment Canada survey reports that 85.2% of Nova Scotians over 15 years of age participate in a wide range of nature-related activities (DuWors et. al. 1996).

Though the percentage of these activities taking place in forested landscapes is not available, the numbers clearly represent a very important non-timber use of forests that depends on the maintenance of pristine forests, wilderness areas, and protected areas.[93]

The following Environment Canada survey results were reported in Section 11.4.1 above, but are repeated here because they are also applicable to this indicator. In 1996, 326,000 Nova Scotia residents spent 5.6 million days participating in outdoor activities in natural areas, and 130,000 residents spent 2.5 million days viewing wildlife (Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians. 2000).

Total expenditures by Nova Scotia residents on nature-related activities increased from $165.1 million in 1970 to $249.7 million in 1996 ($1997; Table 10). While most of these expenditures do appear in the conventional economic accounts, they are recorded by industry and are generally not aggregated as an indicator of the value and importance of wildlife.

A caveat here is that there have been changes in the format of surveys conducted by Environment Canada in recent years. Therefore, the 1996 numbers are not strictly comparable to earlier estimates. They are included here because there are no comparable data that would allow a more accurate time series. GPI Atlantic recommends that the province and Environment Canada conduct a survey that allows proper comparison.

A second caveat, as noted above, is that nature and wildlife-related activities and associated expenditures are clearly not synonymous with recreational activities within forest ecosystems alone. Information currently available does not allow a breakdown of the above expenditures by ecosystem type. However, it may be assumed that the proportion of such activities within forest ecosystems is significant. Furthermore, the state of the province's environment and its

[93] In addition to the lack of information on the proportion of these activities taking place in forested areas, there is no information from these surveys on the proportion of activities taking place in forests where timber harvesting occurs. The results are not, therefore, compared with timber harvest activities nor assumed to be mutually exclusive with such activities, but are presented simply to illustrate that nature, wildlife, and recreational activities have a significant economic value that is often overlooked in forest resource management and planning. As Volume 2, Chapter 4, illustrates, skillful management can enhance both timber and recreational values.

attractiveness for recreational pursuits is reflected by the overall quality of all of Nova Scotia's ecosystems.

Table 10. Expenditures by Nova Scotians on Activities related to Nature and Wildlife Values

Year	Non-consumptive expenditures (millions)		Consumptive expenditures (millions)		Total expenditures (millions)	
	Current $	1997$	Current $	1997$	Current $	1997$
1970	17 (44%)	72.1	21.9 (56%)	93.1	38.9	165.1
1973	10.6 (27%)	38.7	26.4 (73%)	96.4	37.0	135.1
1987	55.6 (53%)	72.8	49.7 (47%)	65.1	105.2	137.9
1996	69.2%[94]		27%[95]		244.8[96]	249.7

Sources: Province of Nova Scotia, 1993; DuWors et. al. 1996.

It should also be noted from Table 10 that a significant shift in the nature of wildlife and nature-related activities has occurred. A substantially greater percentage of expenditures are currently spent on non-consumptive activities, such as hiking and bird-watching (presently 69.2%, up from 44% in 1970 and 27% in 1973), than consumptive activities like hunting and fishing (presently 27%, down from 73% in 1973). Although definitive interpretations are not possible here, the decline in consumptive expenditures in the 1990s is likely related to the decline in recreational fishing expenditures noted above.

The Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians (2000) estimated that these nature-related activities made a contribution to Nova Scotia's GDP of $242.3 million (1996$) in 1996. In addition, local and provincial governments received almost $82 million in revenue from these activities. Furthermore, the value of nature-related activities, above and beyond these expenditures, is worth an additional estimated $63.8 (1996$) million, which is the total amount that survey "participants stated they would be willing to increase their expenditures (by)...before deciding to forego these activities." Therefore, the total potential value of nature-related activities to the Nova Scotia economy is about $300 million a year.

Hiking Trails

Although no precise breakdown of hiking trail use by landscape type exists, there is no doubt that hiking is largely dependent on the maintenance of pristine forests, wilderness areas, and protected areas. Old-growth forests and mature forests exhibiting old-growth characteristics, that have a diverse array of Acadian forest plant and animal species, contribute directly to the attractiveness of Nova Scotia's hiking trails. The quality of the hiking experience in turn has direct economic impacts.

[94] Includes outdoor activities in natural areas and wildlife viewing.
[95] Includes recreational fishing and hunting.
[96] Economic benefits accruing as a result of nature-related activities by residents of Nova Scotia.

A survey of Nova Scotia hiking trail users, prepared for the Nova Scotia Department of Economic Development and Tourism, estimated that annual aggregate expenditures associated with the use of Nova Scotia hiking trails is $90.5 million ($1999). This includes $79.4 million from tourist trails to reach hiking designations, and $11.1 million associated with the use of hiking/walking trails themselves. When this revenue was adjusted to take into account the primary influence of the trail system on the selection of the destination, the aggregate spending of trail users was calculated to be $34.3 million ($1999) per year (Gardner Pinfold Consulting Economists Ltd. 1999).

Because nature tourism is recognized to be the fastest growing sector of the burgeoning tourism industry, the Nova Scotia Department of Economic Development commissioned the ARA Consulting Group to undertake a study for the development of a Nova Scotia Nature Tourism strategy. Referring to the results of nature tourism surveys, the study found that nature tourism travellers typically stay longer and spend substantially more than other tourists (Nova Scotia Economic Development and Tourism 1997).

The report states that there is a clear indication that a natural setting is the key determinant for the selection of a destination by nature tourists. Based on the percentage of respondents who indicated a definite interest in taking a nature trip to Nova Scotia, the consultants concluded that an additional market of $1.3 million for nature tourism in Nova Scotia presently exists beyond current revenues.

The following is a selection of the report's conclusions on essential requirements for further development of the nature tourism industry:

a) A natural setting is critical.
b) The marketplace is increasingly looking for tourism packages that respect the environment.
c) Respondents most often mentioned walking, wildlife viewing, boating, and hiking as their activities of choice.
d) Parks and protected areas rate very highly in importance.
e) Parks may also be significant for potential winter nature tourism.

The top concern of stakeholders, including operators, industry associations, and government agencies, is the importance of the conservation of Nova Scotia's natural spaces. The report recommends that government and industry make nature tourism a priority. The consultants emphasize that nature tourism is a growth market with a broad audience and significant market potential.

The report also recommends that a nature tourism resource inventory be undertaken to ensure that important tourism areas be sustainably managed for long-term use. Such an inventory can be particularly helpful in correcting confusing messages currently transmitted to tourists concerning apparent nature designations that are not in fact managed for that purpose. The Liscomb sanctuary, for example, appears on maps as a large green nature area. However hikers and ecotourists have reportedly found vast clearcuts during visits.

Quite clearly, the ARA recommendations to the Department of Economic Development cannot be successfully implemented in isolation from comprehensive policies that support best forest management practices and a comprehensive system of protected areas. The potential gains to the provincial economy from the development of nature tourism resources may be reflected in financial incentives for forest management practices that protect and restore the natural diversity, structure, wildlife habitat, and integrity of Nova Scotia's Acadian forests.

11.6.3 Number of provincial residents contributing to nature-related organizations

According to a 1996 survey, 33,000 Nova Scotia residents, or 3.5% of the total population, reportedly contributed to a nature-related organization in 1996 (DuWors 1996).

11.6.4 Value of tourism revenues

An assessment of the growing importance of nature tourism and the significant market potential identified in the Department of Economic Development study must be considered against the background of the growth of the tourism industry in Nova Scotia. Although no breakdown is currently possible to indicate the proportion of tourism revenues that are dependent on forest visits and recreational opportunities, the growing attractiveness of Nova Scotia as a tourism destination clearly has much to do with the perceived quality of its environment and the beauty of its landscapes. The following statistics indicate the rapid growth of the industry as a whole in the last three years alone.

In 1997, the number of Nova Scotians employed in tourism was 11,100 (full-time equivalent direct jobs), a figure that is comparable to the number of direct jobs in forest industries (logging, wood industries, and paper and allied industries).[97] The total direct and indirect tourism-related jobs were 15,400 (full-time equivalent). In 1998, the number of direct tourism jobs rose to 11,300 (an increase of 200 jobs from 1997), and the total direct and indirect jobs rose to 15,700 (an increase of 300 jobs). In 1999, the total number of direct and indirect jobs increased by 3,600, a remarkable 23.4% increase in just three years.

Similarly, total tourism revenues rose from $1.04 billion in 1997 to $1.1 billion in 1998, to $1.26 billion in 1999, a 21% increase. In addition, tourism generated $171 million in taxes in 1997 and $179 million in 1998 (Table 11). These economic indicators clearly demonstrate the growing importance of tourism as a significant economic sector in the province, with nature tourism the fastest growing sector within that industry.

In short, the growing economic importance of the nature tourism industry in Nova Scotia now challenges the *economic* wisdom of current forestry practices and policies. The question is

[97] Peter Woolaver, NSDNR, (2001), correctly points out that a more careful analysis and comparison of employment in the tourism and forestry industries would compare wages, working conditions, and job security, in addition to total numbers of jobs. This has not been possible for this first effort in the construction of forest accounts for the province but should be included in future updates of the report. Chapter 9 in Volume 2 takes one step in this direction by exploring the economics of logging employment more closely. Similar analyses should be undertaken for other job categories in both the forestry and tourism industries.

particularly pertinent at a time when sharply escalating rates of clearcutting may threaten the integrity of the remaining forested landscapes that potentially make Nova Scotia such a desirable destination for a growing number of nature tourists. At the very least, effective management must ensure that timber harvesting practices do not undermine a resource that is essential to a mainstay industry on which thousands of Nova Scotian jobs depend.

Table 11. Tourism revenues, taxes generated, and employment

Year	Receipts (1997$ billion)	Total taxes generated (1997$ million)	Provincial & Municipal Taxes (1997$ million)	Direct Employment (full-time equivalent)
1997	$1.04	$171	$102.00	11,100
1998	$1.09	$177.8	$105.31	11,300
1999	$1.26	$201.3	$119.22	

Source: NS Dept. of Tourism and Culture, 1999.

11.6.5 Other Montreal Process recreation and tourism indicators

Two other indicators mentioned in the Montreal Process framework, for which more specific information should be gathered in future report updates, are:

1) the area and percent of forest land managed for general recreation and tourism, in relation to the total area of forest land; and
2) the number of visitor days attributed to recreation and tourism in relation to population and forest area.

11.7 Economic Contribution of Other Non-Timber Forest Goods and Services

This chapter has focused on the economic and social contributions of selected non-market forest ecosystem values, and of two market values - sugar maple products and nature tourism - that are dependent on overall forest integrity. However this is clearly not an exhaustive account of the multiple benefits of forests to society. It should rather be taken simply as illustrative of the types of goods and services that are often neglected when forest values are assessed in the conventional economic accounts and measures of societal progress, and when forest management practices consider timber values in isolation from other ecological and social benefits.

One indirect indicator of the importance of these non-timber forest values is that, according to a 1993 NSDNR survey of Nova Scotia woodlot owners, only 25% indicated timber production as one of their original reasons for acquiring land in NS and for continuing to keep that ownership.[98]

[98] P. MacQuarrie, NSDNR, pers. comm. 2001.

Future updates of this report should consider a wider range of benefits provided by forests, including the contribution of other non-timber sectors to the Gross Domestic Product; the utilization of forests for other non-market goods and services; and the economic value of these non-market goods and services.

The Montreal Process also includes the following specific indicators:

- the supply and consumption/use of non-wood products;
- the degree of recycling of forest products.

For example, the following specific forest values, not discussed in this chapter, could be considered in future updates of these forest accounts, both for their benefits to society and for their contributions to the economy:

- the spiritual value of forests, especially for the native Mi'kmaq peoples, and the social value of forests in strengthening communities;[99]
- food sources including specialty mushrooms, ginseng, herbs, and medicinal plants;
- cultural and educational uses of forests, such as the Maritime School of Ecoforestry that each year attracts dozens of students from throughout Canada and the United States; and
- a wide range of other ecosystem services, including water supply, regulation and filtration.

11.7.1 The Integrated Resource Management Plan

In September, 2000, an Integrated Resource Management Plan (IRM) for provincial Crown lands was unveiled by the NSDNR after a series of public consultations and several years of preparation. This is a land use plan, *not* a forest management plan. However its intent is to recognize the multiple benefits of forests to society, to balance timber extraction with other interests, and therefore to address some of the issues raised in this chapter at least in respect to the 28% of forest land owned by the province.[100]

Time and resources did not permit an analysis of the IRM for this study, and a thorough exploration of this issue should be part of future updates of these accounts. However, it must be acknowledged that the plan has been highly controversial. It has been very favourably received by the forest industry, particularly by the largest players. However many Nova Scotian organizations do not regard the IRM as achieving its objectives of multiple and balanced resource use. For example, members of the province's Public Lands Coalition, a consortium of 37 hunting, fishing, tourism, recreation, naturalist, environmental, aboriginal, and scientific groups that collectively represent over 15,000 Nova Scotians have serious objections to the plan.

Bob Bancroft, President of the Nova Scotia Federation of Anglers and Hunters, a member group of the Coalition, maintained that:

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[99] See Volume 2, Chapter 2, for a more detailed description of the social value of forests, as manifested in a Mi'kmaq community in Nova Scotia.
[100] For an introduction to the IRM, see: www.gov.ns.ca/natr/irm/introduction.html. For the plan's stated goals and objectives, see: www.gov.ns.ca/natr/irm/goals.html.

"*This plan was supposed to bring different government policies together in a unified and balanced approach. Instead, one government department [the NSDNR] has decided that the lion's share of Crown lands is for industry, while the rest of us are sitting on the sidelines*" (Bancroft 2000).

According to Kermit deGooyer, Co-ordinator of the Ecology Action Center's Wilderness Campaign:

> *"The Coalition has been critical of many aspects of Integrated Resource Management (IRM) planning and has lobbied for changes to the process to make it more transparent, progressive, and reflective of public aspirations. Central to our position is the belief that Nova Scotia will enjoy the most benefits from our limited public land base if many more Crown lands acquire legal protection.*
>
> *We believe, and hope, that the Department has recognized that the IRM strategic plan was very poorly received in many circles, including the tourism industry, environmental groups, hunting and fishing clubs, scientists, some Mi'kmaq interests, much of the general public, some government departments, and several community groups and municipalities. An underlying concern among these interests remains that the IRM strategic plan is not fairly balanced – it heavily favours industrial resource extraction and industrial users at the expense of non-consumptive values and nearly everybody else with an interest in public land"* (deGooyer 2001).

These critiques indicate a clear need for a thorough investigation of the success of multiple resource use planning in the province. The non-timber forest values and associated resource use issues investigated in this chapter should be part of such an evaluation, in order to assess the extent to which the IRM process addresses the protection of these values.

Another clear gap in this analysis of social benefits in this chapter, which definitely merits future study, is the impact of land ownership patterns on alternative resource uses and on the distribution of benefits.[101] Most of the non-timber benefits of forests to society considered in this chapter accrue to the public. But compared to most other provinces, Nova Scotia has a particularly high rate of private ownership of forest lands. Therefore, policy options to ensure an adequate flow of non-timber benefits to the public from Nova Scotia's forests will require a very different set of policy options than in other provinces where most land is publicly owned, with market-based incentives likely to play a greater role than regulation for example.

12. Forest Timber Values

Because non-timber forest values, particularly ecosystem functions, have been largely invisible in standard accounting procedures, and because forest ecosystem integrity is the essential prerequisite for sustainable timber supply, this study has so far focused on these neglected values. However timber clearly provides multiple and essential benefits to human society, including building materials, paper, fuel, packaging materials, and more.

[101] GPI Atlantic is indebted to Peter MacQuarrie, NSDNR, (2001) for this very helpful insight.

It would therefore be a serious mis-reading of this report to interpret the emphasis on forest ecosystem functions as being an argument against timber extraction. On the contrary, the emphasis on ecosystem health and integrity should be seen as an argument for ensuring long-term timber values, productivity, and availability. And well-managed forests are shown in Volume 2 to enhance both the timber and non-timber values of forests.

However, at the same time, these accounts have noted the necessity for an ecologically viable system of protected areas that ensures the conservation of wild areas, including adequate representation of all of Nova Scotia's eco-regions. Outside of these protected areas, timber harvesting can be managed to protect future timber values and productivity, as well as to protect non-timber forest values. This chapter considers the provision of a timber as a vital social and economic benefit of Nova Scotia's forests.

12.1 Management Expenditures, Economic Contribution and Employment

12.1.1 Timber: The supply side

Natural resource accounts, including these GPI forest accounts, inevitably focus on the supply side of the sustainability equation, in essence putting the onus for sustainable use on the harvester and producer. This is a critical part of the equation, and this report makes clear that the dramatic loss of Nova Scotia's old forests, of their natural species and age diversity, and of their capacity to provide vital ecosystem functions and services, is due in large part to a long history of misguided harvesting methods. The following section acknowledges that the other (more often overlooked) side of the sustainability equation is consumer demand for timber products. From that perspective, responsibility for sustainable use rests with the consumer at least as much as with the producer.

Historically, the failure to protect the full range of forest values and the consequent decline in value of the province's forests have been due in part to our limited understanding of ecological systems. Until the late 1960s, natural resources were often assumed in modern industrial society to be infinite, and there was little understanding either of the limited carrying capacity of the earth's resource base or of the necessity to protect vital ecosystem services that were essentially "free." There was little social awareness that limitless and careless timber extraction would compromise other essential forest services and endanger the value of the timber supply itself.

In modern industrial society, unlike most native traditions, it is only recently that the linkages between ecosystem integrity, and human and societal well-being have been explored and at least partially understood. In most native traditions, natural assets and services were deeply respected and revered because they provided the very basis for human existence. What was obvious to most native traditions through simple observation, experience and common sense has required the mediating hand of science in industrial societies to give legitimacy to the vital role of ecosystem functions in sustaining life on earth.

Fortunately, the necessity for protecting and conserving natural capital assets and the ecosystem services that they provide is now widely, if not universally, acknowledged and accepted in industrial societies, at least in theory. With greater understanding of the functions of natural capital assets and of the benefits of ecosystem services to human society, new knowledge on sustainable harvesting methods and techniques has been developed.

From a supply perspective, there is a clear need to embrace viable and sustainable timber harvest methods before it is too late. A 1997 report by the National Round Table on the Environment and the Economy contained warnings that the forest industry in this region might be on the verge of a collapse analogous to that of the ground fishery (NRTEE 1997).

Sustainable timber harvest methods for Acadian forests, and their economic viability, are described very briefly in the last chapter of this volume and in considerably more detail in Volume 2. Case studies of best forest practices both in Nova Scotia and elsewhere are presented in Volume 2 as models that can restore the value of the province's forests and ensure a sustainable wood supply for generations to come.

This study proposes that Nova Scotia as a whole take the lead in committing itself to further development and advancement of low-impact, uneven aged forest management systems that could provide a collective model of best practices for other jurisdictions. Given the lead already taken in this region by the Forest Stewardship Council with the promulgation of *Certification Standards for Best Forestry Practices in the Maritime Forest Region* (FSC 2000), a Nova Scotia "showcase" of ecologically-sustainable harvest practices for temperate uneven aged forests could yield tremendous economic benefit.

As the experience of the Maritime School for Ecoforestry in New Germany, Nova Scotia, has already demonstrated, a world-class training centre of sustainable forest practices could attract students and observers from far afield if the province became known for its commitment to "best practices."

12.1.2 Timber: The demand side

However, there is a critical and much more challenging side to the sustainability equation, which even the most responsible timber harvest practices cannot address. That is the seemingly insatiable consumer demand for timber products that suppliers attempt to fulfil both for their own economic survival and to meet equally insatiable shareholder demands for higher rates of return on investment.

Indeed, even the most comprehensive natural resource accounts will always imply that the onus for sustainability is on the suppliers through their harvest methods. These accounts in isolation cannot properly address the consumption side of the equation that essentially drives suppliers to extract ever more product from the world's forests. The *demand* side of the sustainability equation can only be addressed through the much more difficult process of addressing consumption habits, including reduced use, re-use, and re-cycling.

For this reason, the Genuine Progress Index includes an *Ecological Footprint Analysis* as one of its core accounts (Wilson, J. 2001). This component of the GPI places the onus for sustainable development equally on the shoulders of consumers by assessing the environmental impact of current consumption habits, including resource use in relation to global resource availability. One key element in the ecological footprint calculation *is* timber use. Therefore, the consumption side of the forest sustainability equation is addressed in that study.

By stark contrast to measures of progress based on the GDP, a *smaller* ecological footprint signifies genuine progress. Unlike assessments of well-being and prosperity based on economic growth measures, in which "more" is always "better," "less" is frequently "better" in the GPI. Ecological footprint, crime, pollution, and greenhouse gas emissions are key examples of GPI indicators where progress is measured by a reduction rather than an increase in activity.

It is essential to point out the *demand* side of timber, in order to acknowledge the limitations of this set of forest accounts. For a more complete understanding of sustainable resource use that includes both supply and demand, the GPI natural resource accounts must therefore be read in conjunction with the *Ecological Footprint Analysis* (Wilson, J. 2001). It should be noted that both the supply *and* consumption of wood and wood products, including consumption per capita, are key Montreal Process indicators. Because consumption requires its own detailed analysis and calculation, that discussion is not included in this report but is available in the *Nova Scotia Ecological Footprint Analysis* (Wilson, J. 2001).

12.1.3 A data limitation

Recognizing the limitations of a supply-side analysis alone, the following sections nevertheless assess current Nova Scotia timber values and examine the contribution of the forest industry to the Nova Scotia economy. Better information is available for this component of the forest accounts than for any other segment, because it is regularly tracked in the conventional economic accounts. Strictly speaking, the GPI approach requires a re-definition of the term “forest industries” to include non-timber resource-dependent industries.[102] However, to avoid confusion, this chapter uses the term exactly as in the conventional economic accounts, to include logging and forestry, wood products, and pulp, paper and allied products.

A recent report on the Nova Scotia forest industry, prepared by the Atlantic Provinces Economic Council (APEC 2000) for the Nova Scotia Forest Products Association, produces different employment and output results than those described in this chapter. This is partly because the APEC report uses the new North American Industry Classification System (NAICS), that substantially changes both the industry definitions and the consequent employment and output calculations for the forest industry. These new definitions make historical comparisons and time series difficult, because long-term data available from Statistics Canada’s CANSIM database are still based on the Standard Industrial Classification (SIC) that was historically used by the agency.

[102] For example, the recent application of the Tourism Industry Association of Nova Scotia (TIANS) to the Forest Stewardship Council indicates the necessity for broadening the conventional definition. Nature tourism could be considered a “forest industry,” since it is resource-dependent for its existence.

Volume 2, Chapter 8, describes some of the differences in forest industry employment estimates from various sources. As one example of the confusion, the APEC report counts construction-related activity at sawmills and pulp and paper mills as direct forest industry employment, while this report would classify these jobs as construction industry employment, and thus indirect rather than direct jobs generated by the forest industry.

The APEC report also includes forestry related government employees, trucking of logs and wood products, suppliers of forestry equipment, Christmas trees, and maple syrup production in the forestry sector.[103] These sectors are generally classified in other industrial categories. For example, since 1996, Statistics Canada has counted Christmas tree production as part of its *Agriculture Economic Statistics* and farm cash receipts (Statistics Canada 2000).

Further investigation by GPI Atlantic researchers, subsequently confirmed by APEC, found 3,363 jobs counted twice in the APEC report, once as direct employment and a second time as indirect employment, thus inflating the total employment statistics reported as generated by the forest industry.[104]

Resources were not available for GPI Atlantic to re-do the historical SIC-based calculations using the new NAICS classifications in the APEC report. Instead, this chapter is based on the historical provincial forest industry contributions to GDP provided by the Statistics Division of the Nova Scotia Department of Finance, and available through Statistics Canada's CANSIM II database. The employment statistics were taken from the National Forestry Database maintained by the Canadian Forest Service of Natural Resources Canada, and from Statistics Canada's CANSIM II database. These are all highly reliable and official government sources, and provide accurate comparisons over time using comparable categories and classifications.

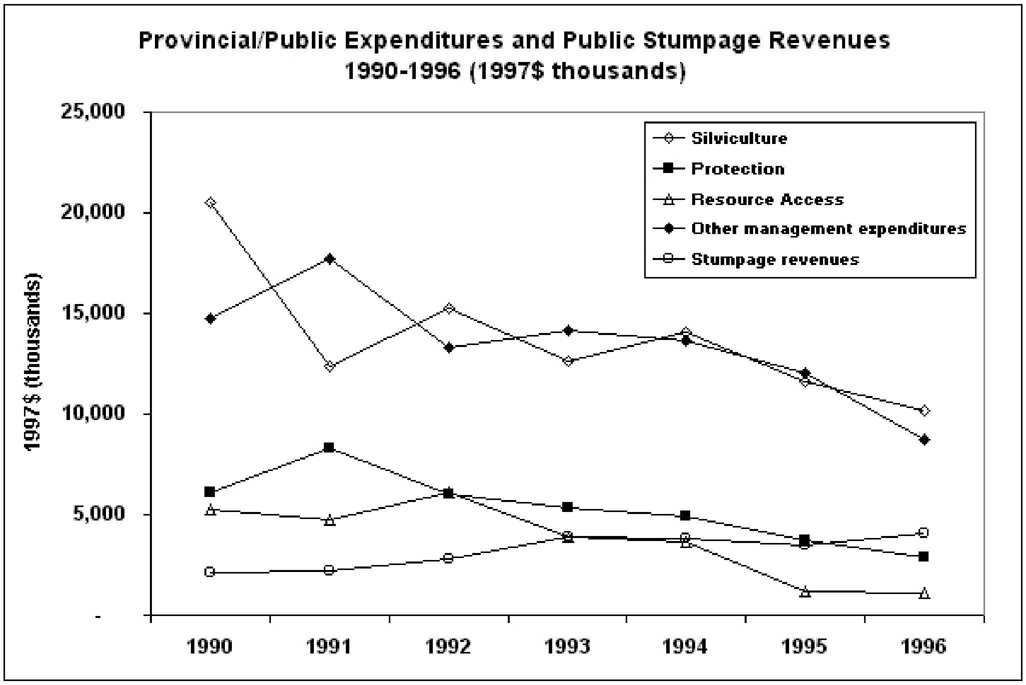
However, given the divergence in current results and calculations, it is recommended that this chapter be read in conjunction with the APEC (2000) report on the Nova Scotia forest industry. GPI Atlantic also recommends that future updates of this report attempt to adjust the historical comparisons over time to the new NAICS categories in order to allow better historical comparability with the figures most commonly used in policy circles today.

12.2 Provincial and Federal Forest Management Expenditures

During the period 1990 to 1996, combined provincial and federal forest management expenditures for Nova Scotia declined from $46.6 million ($1997) to $22.8 million ($1997), a decline of 51% in less than a decade. Figure 12.1 illustrates the significant decrease in silviculture, protection, resource access, and other management expenditures that has occurred over this time period. The withdrawal of federal funding for silviculture and forest management is the primary cause of the decline in public expenditures. At the same time, stumpage revenues have increased from $1.8 million ($1997) to $4.0 million ($1997) (Figure 27).

[103] The authors are grateful to Peter Woolaver, NSDNR, (2001), for this clarification.
[104] See Volume 2, Chapter 8, for further details on this double-counting and on the difficulties of accurately assessing forest industry employment.

Figure 27. Provincial/Public Expenditures and Public Stumpage Revenues 1990-1996 (1997$ thousands)



Source: National Forestry Database.

Further analysis of these public management expenditures is necessary to determine the extent to which public spending in excess of stumpage revenues constitutes a taxpayer subsidy to industry. For example, resource access (e.g. road building) is the single largest management expense, and may well constitute a taxpayer subsidy for industry operations. Time and resources did not permit such an analysis in this study, but it should be included in future report updates.

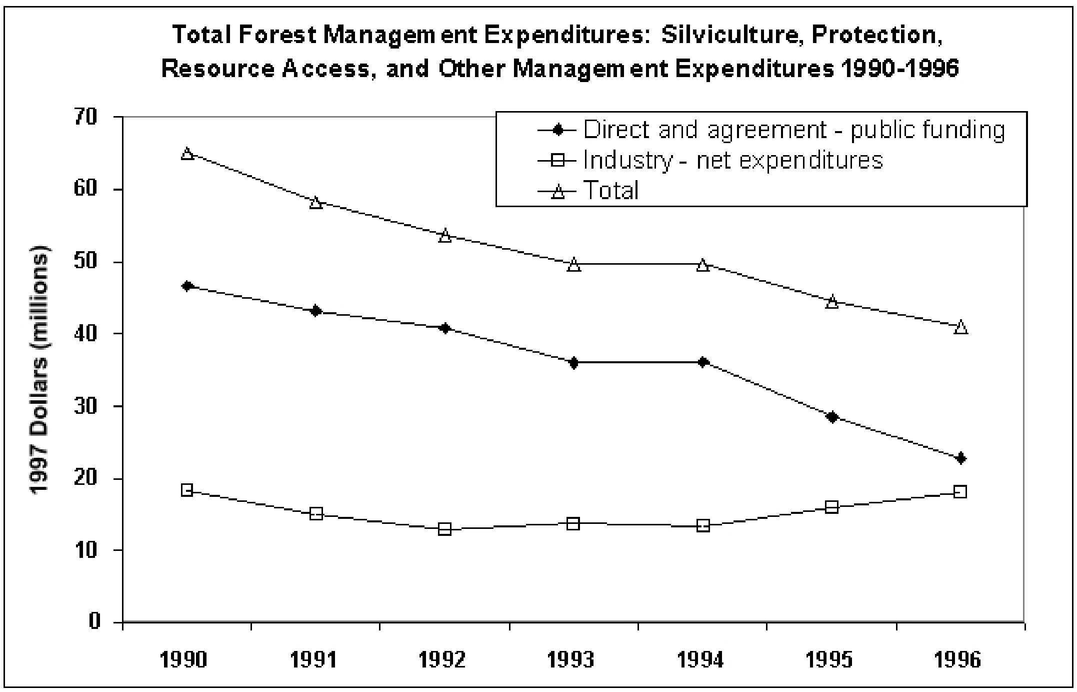
12.2.1 Public and private forest management expenditures

Similarly, total Nova Scotia forest management expenditures (public and private) decreased by $24 million 1990 from $65 million ($1997) in 1990 to $41 million ($1997) in 1996, a 37% decline (Figure 28). Declines in public funding have been more dramatic than the change in private expenditures. In 1996, overall public expenditures for silviculture, protection, resource access, and other management activities were 51% lower than 1990 levels.

Industry net expenditures, prior to 1996, had been substantially lower than public expenditures (Figure 28). However, with the rapid decline in public funding, public expenditures exceeded industry net expenditures in 1996 by only $4.7 million, whereas, in 1990, public expenditures were $28.2 million greater than industry net expenditures ($1997). Industry net expenditures were $18.1 million in 1996 ($1997), relatively similar to 1990 expenditures. Industry spending decreased in the early 1990s from a high of $18.4 million ($1997) in 1990 to a low of $12.9 million ($1997) in 1992 and then gradually recovered to 1990 levels.

In short, there has been an increasing tendency in Nova Scotia to devolve responsibility for forest management from the public sector to industry, so that self-regulation is becoming increasingly the norm. In 1990, public expenditures accounted for 72% of forest management costs, and in 1996 for only 56% of forest management expenses. But industry spending on management has climbed only very slowly since its low point in 1992, is still slightly lower than 1990 industry spending levels. From the sharp overall decline in total forest management expenditures, therefore, it is clear that industry self-management and regulation has not effectively replaced public sector management.

Figure 28. Total Forest Management Expenditures: Silviculture, Protection, Resource Access, and Other Management Expenditures (1990-1996)



Source: National Forestry Database.

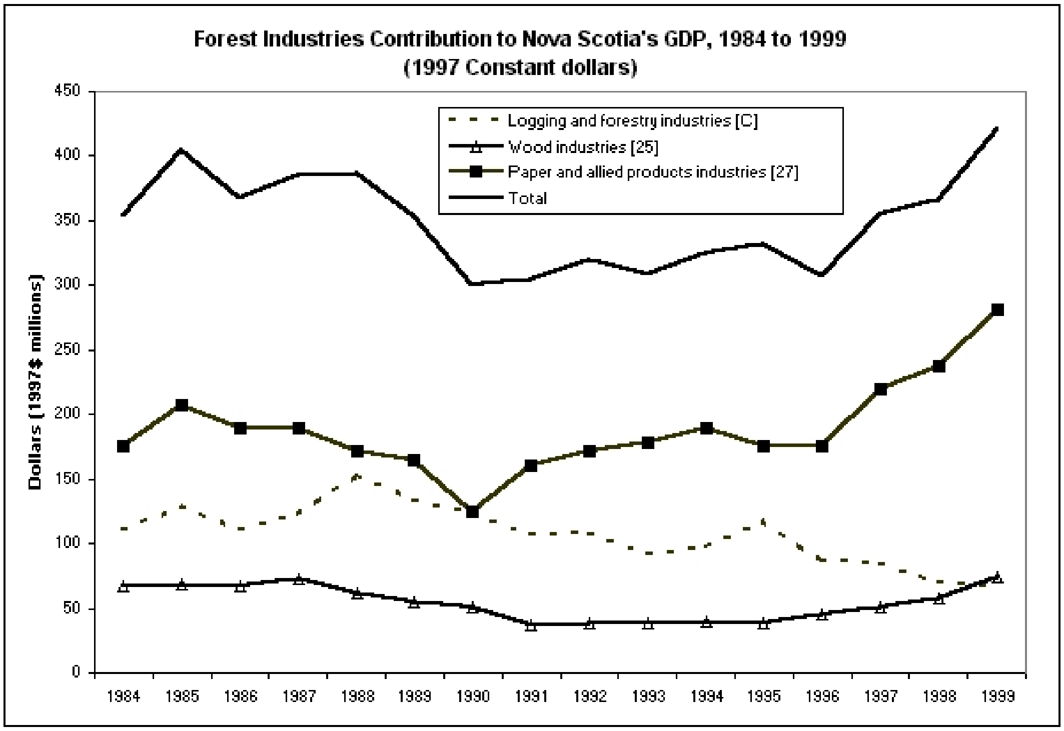
12.3 Value of Wood Products as Percentage of GDP

The forest industry's contribution to the provincial gross domestic product (GDP) increased by 4.4% from its 1985 peak of $404.1 million (1997$) to $421.7 million in 1999 (1997$). Comparable historical statistics in Statistics Canada's CANSIM II database go back to 1984. The average forest industry contribution to the Nova Scotia economy from 1984 to 1990 was $364.7 million annually (1997$), whereas the average between 1991 and 1999 was $338 million annually (1997$), a decline of 7.3%.

The total contribution of the logging and forestry industries, wood industries, and pulp and paper industries to the provincial GDP decreased from the mid-1980s to 1990, was relatively flat until

1996, and increased sharply in the late 1990s (Figure 29; constant 1997 dollars). The recent increase coincides with a sharp increase in the volume and area of timber logged in the province.

Figure 29. Forest Industries Contribution to Nova Scotia's GDP, 1984-1999 (1997 constant dollars)



Source: Statistics Canada, CANSIM II - Table 379-0003; SIC 1980.

Among the three industrial categories that comprise the forest industry, only the logging and forestry industries have shown an overall decline in their contribution to the provincial economy, while the contribution of the wood industries and pulp and paper industries has increased.

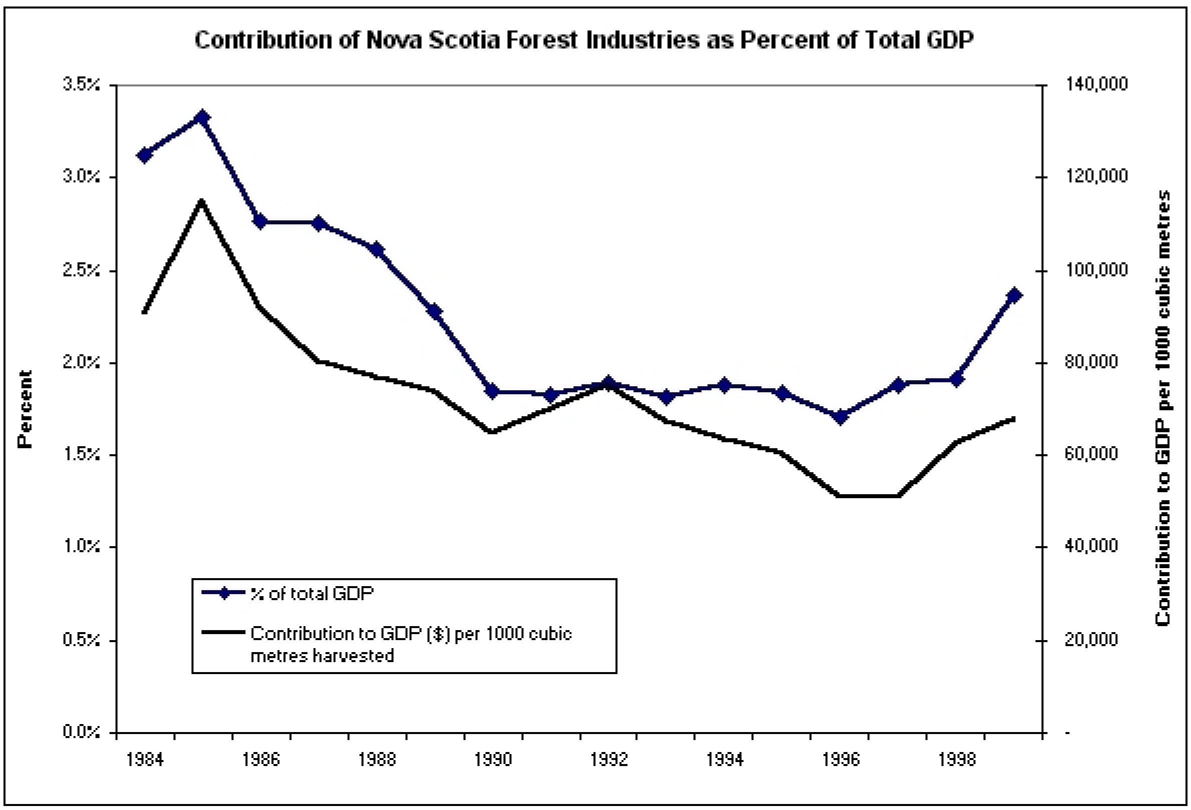
Overall forest industry contributions peaked in 1985, and again in 1999. Thus, an assessment of overall trends depends on the basis of comparison. The forest industry contribution to Nova Scotia's economy increased by 19.2% between 1984 (i.e. the earliest reporting in Statistics Canada time series) and 1999, but only by 4.4% compared to 1985. As noted above, the overall 1990s average (1991-1999) is 7.3% lower than the 1980s average (1984-1990).

The logging and forestry services contribution to the GDP peaked at $153.8 million ($1997) in 1988, whereas, the latest report, in 1999, indicates a contribution of just $65.7 million ($1997), a sharp decline of 57.3%. Wood industries peaked at $72.4 million (1997$) in 1987, decreased by 19.6% to $58.2 million in 1998 ($1997), and then rose to $74.2 million ($1997) in 1999, an increase of 2.5% over the previous 1987 peak level.

The contribution of pulp and paper industries peaked in 1985 at $207.5 million (1997$), decreased in the early to mid 1990s, and has risen sharply by 60% since 1996 to a new record of $282 million in 1999. In the 1980s, pulp and paper represented about 50% of the forest industry contribution to GDP. It now represents more than two-thirds of that contribution. Indeed, most of the recent increase in forest industry contribution to GDP is attributable to growth in the pulp and paper industry. The dramatic growth in the pulp and paper industry runs parallel to the sharp increase in clearcutting and volume of timber harvested in the late 1990s.

The contribution of the forest industry as a proportion of the province's GDP declined gradually from 1984 to 1989 (from 3.3% of GDP in 1985 to 2.3% in 1989). The contribution dropped further in the 1990s, remaining fairly constant from 1990-1998 (between 1.7% and 1.9%), and then increasing to 2.4% in 1999 (Figure 30).[105]

Figure 30. Contribution of Nova Scotia Forest Industries as Percent of Total GDP



Source: Statistics Canada, CANSIM II - Table 379-0003; SIC 1980.

From the perspective of sustainability, however, the forest industry's contribution to GDP must be assessed not only in relation to the value of timber sold at market, but to the value and health of the standing forest. In conventional accounting mechanisms, the forest industry contribution to

[105] This study confines itself to a description of these trends. Time and resources did not permit an explanatory analysis of the changing proportion of forestry contribution to GDP.

GDP can grow through the depletion of natural capital. The more trees that are cut and the faster they are cut, the more the economy will grow. Similarly, increased ground fish catches and sales in the late 1980s and early 1990s made the GDP grow, even as ground fish stocks were being depleted to the point of collapse.

For this reason, the GPI assesses contribution to the GDP in relation to volume of biomass harvested. Higher levels of value added manufacturing can increase GDP contribution without depleting stocks, and may be signalled by a higher ratio of GDP contribution to volume of biomass harvested. Conversely, a rising GDP contribution accompanied by a lower ratio of GDP contribution to biomass harvested may signal declining value if the natural capital stock is degraded or depleted.

When assessed from this sustainability perspective, there has been a sharp and troubling decline in the contribution of the forest industry to Nova Scotia's economy (GDP) per 1,000m^3 of timber harvested. In 1984, the forest industry contributed \$90,804 per 1,000m^3 harvested. In 1999, the industry contributed only \$68,023 per 1,000 m^3 in 1999, a decrease of 25.1% (\$1997), despite a record \$422 million total contribution to GDP.

In sum, short-term forest industry contributions to GDP can be a highly misleading indicator of progress when assessed in isolation from the volume of timber harvested and the health of the standing forest. Simply put, we are cutting down more and more trees to maintain industry growth, while the economic contribution per unit of wood harvested is declining sharply.

The environmental consequences of resource depletion and clearcutting, the predominant method of timber harvesting in Nova Scotia, have been studied and debated, but an economic gain or trade-off has always been assumed. Figure 30 challenges that assumption and indicates that the doubling of the area of forest clearcut between 1992 and 1997 was accompanied by a decline in economic benefits per 1,000 cubic metres during the same period. Over a longer time span, the volume of timber harvested has doubled since the 1980s, but the forest industry proportion of GDP is less than it was in the 1980s. Although further investigation into these correlations is required, GPI Atlantic here posits the hypothesis that the declining ratio of forest industry GDP to volume of biomass harvested may be an indicator of declining resource *and* economic sustainability.

From the GPI perspective, there are two clear ways to increase the forest industry contribution to the GDP without depleting the value of the natural capital asset on which timber flows depend. The first is to increase the quality of the standing timber stock by restoring the age and species structure of the original Acadian forest, and thus increasing the unit value of timber. This will make it possible to market higher quality products at premium prices as the case studies in Volume 2 demonstrate. The second method is to encourage a higher proportion of value-added manufacturing, which can increase employment and the GDP contribution of the forest industry without depleting natural capital.

Even by conventional accounting standards, the vastly increased rate of timber harvesting has not produced a commensurate economic gain when assessed by comparison with provincial growth rates or the proportion of forest industry contribution to provincial GDP. If the full costs of timber harvesting were included, including impacts on ecosystem services, carbon storage, wildlife habitat, recreational values and other forest values, then the net economic benefit of timber harvesting in the last decade would be considerably less than the GDP statistics given above.

Again, it must be repeated that none of this is an argument against timber harvesting. Volume 2 of these accounts presents six detailed case studies in which timber harvesting and forest management practices are entirely compatible with the preservation and enhancement of non-timber forest values. Those case studies also demonstrate the long-term economic viability of sustainable harvesting practices, and the potential to increase the forest industry contribution to the economy.

12.4 Employment

12.4.1 Total employment in forestry industries

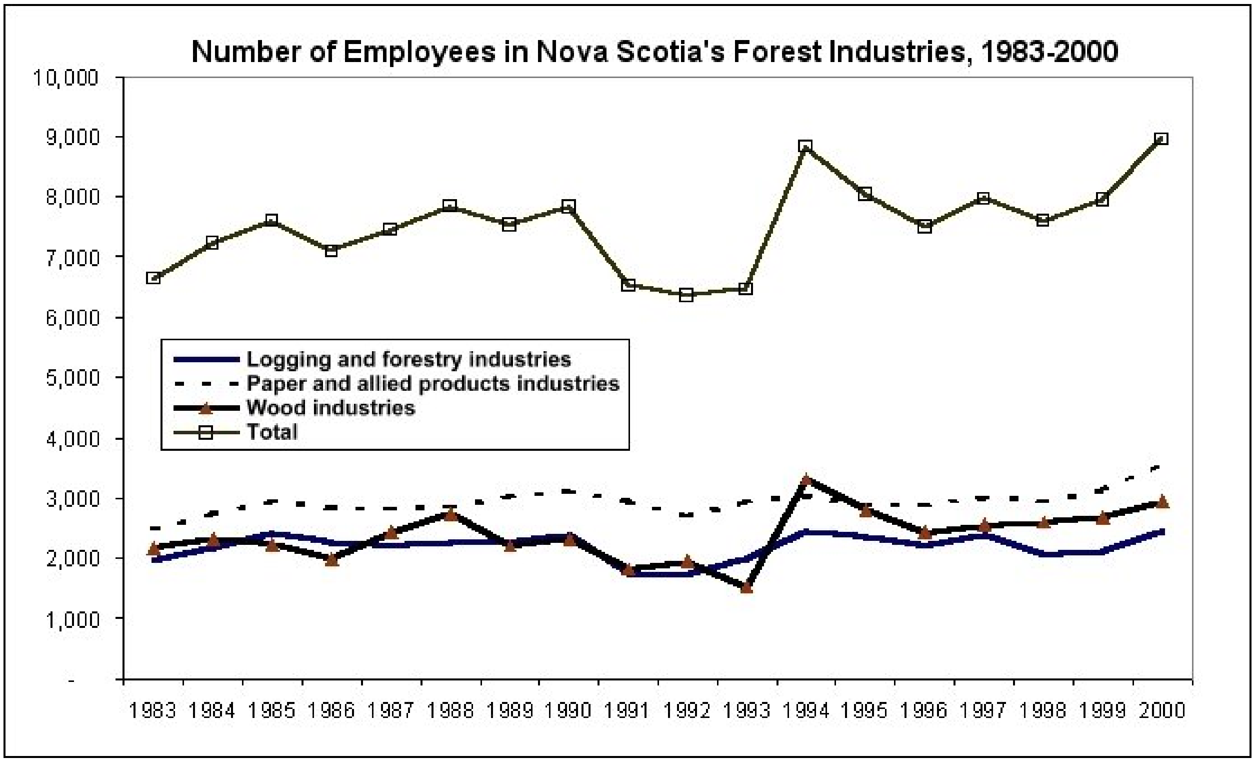
Assessments of forest industry employment vary according to the source used. The APEC (2000) report, prepared for the Nova Scotia Forest Products Association, puts direct forest industry employment at 13,000. As noted, this includes construction at sawmills and pulp and paper mills, which is elsewhere classified as indirect forest industry employment and direct construction employment. The APEC report also counts forestry related government employees, trucking of logs and wood products, suppliers of forestry equipment, Christmas trees, and maple syrup production, which are often classified in other industrial categories.

Other estimates put forest industry employment lower. According to Statistics Canada's Manufacturers Survey (1960-1997), direct forest industry employment has remained fairly steady over the past four decades, but is less now than the number employed in the 1970s and the mid to late 1980s. The latest year in this time series indicates that 6,075 were directly employed in 1997.

This report uses Statistics Canada’s Survey of Employment, Payroll and Hours, which provides an intermediate figure of about 9,000, and also gives an 18-year times series that allows an assessment of changes over time. According to this source, the total number of people directly employed by forest industries in Nova Scotia between 1983 and 2000, including wood industries, paper and allied industries, and logging, is presented in Figure 31. Overall, total forest industry employment was highest in 2000, when 8,956 persons were employed. The average employment between 1983 and 1989 was 7,341 persons, and the average employment from 1990 to 2000 was 7,636, an increase of 4%.

Assessments of employment trends also differ depending on both source and base year used. The APEC (2000) report, prepared for the Nova Scotia Forest Products Association, indicates that forest industry employment grew by 61% between 1992 and 1998. Statistics Canada's Survey of Employment, on the other hand, shows a 19.5% increase in employment over this same time period (6,365 to 7,604 jobs).

Figure 31. Number of Employees in Nova Scotia's Forest Industries, 1983-2000



Source: Statistics Canada, Survey of Employment, Payroll and Hours, CANSIM database.

Also, 1992, the year chosen by APEC as its base year, was a recession year which recorded the lowest forest industry employment of any year between 1983 and 2000. Any comparison with that year will show a sharp increase in employment, regardless of source. Comparing 1998 with 1988, the peak year of reported employment in the 1980s, employment decreased by 3.1%. Comparing 1998 employment to 1994, the peak year in the 1990s, there was a 14% decrease in employment. In 2000, employment increased 1.5% over the 1994 peak, to 8,956. Thus whether one reports an increase or a decrease in forest industry, and the magnitude of that increase or decrease, depends very much on the base year used for comparison.

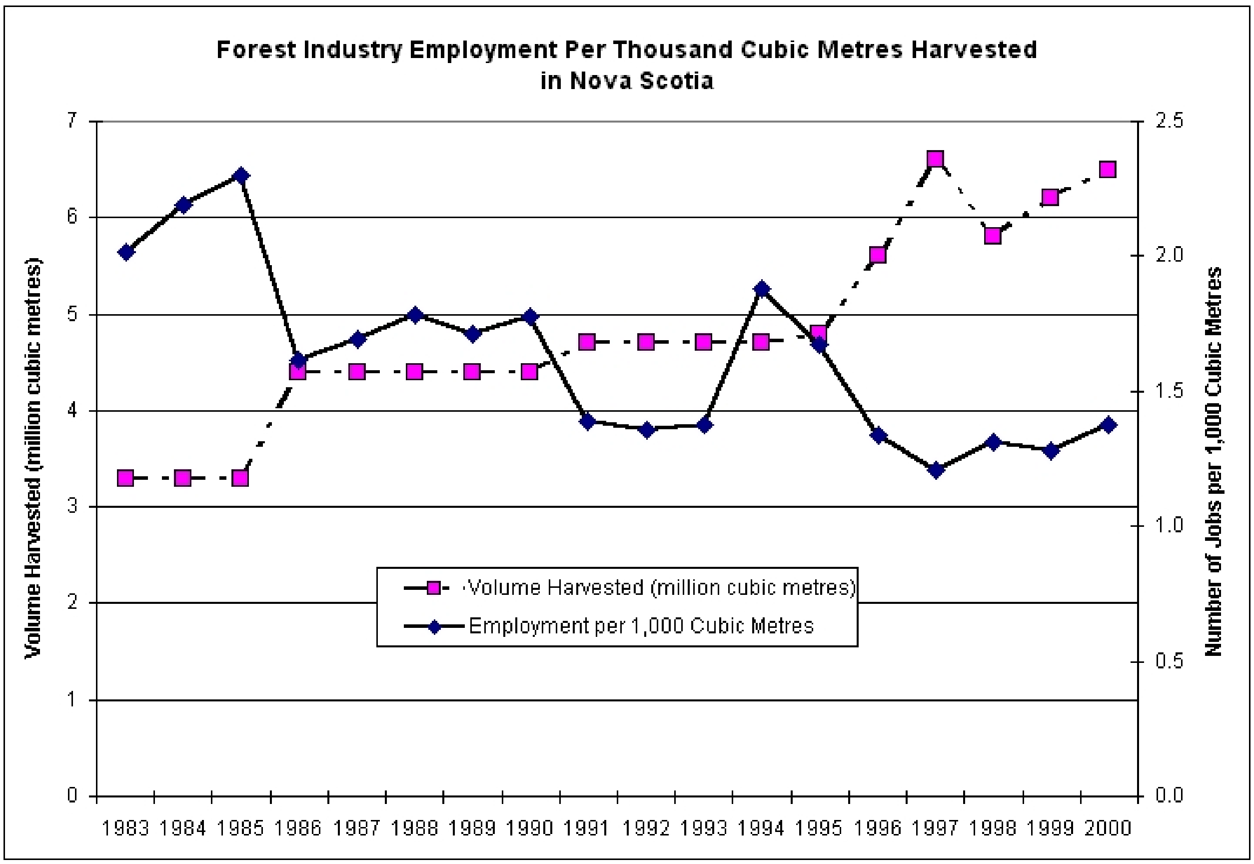
It was also noted earlier that the conflicting employment numbers are partly due to differences between the new North America Industry Classification System (NAICS) now adopted by Statistics Canada, and the Standard Industrial Classification (SIC) system used by the agency in historical time series. Because the new data under the NAICS are not available historically, we have used the longer SIC time series, as reported in Statistics Canada's CANSIM database in this report.

As with the GDP statistics above, it is vital to assess employment in relation to volume of biomass harvested. From the perspective of sustainability and long-term job security, employment depends on the health of the resource. If timber is harvested at an unsustainable rate, or if any natural resource becomes depleted or degraded over time, future employment prospects are threatened, as occurred with the catastrophic collapse of Atlantic ground fish stocks which put 40,000 out of work.

In relation to volume of timber harvested, forest industry employment has declined sharply. Since the 1980s, employment per 1,000m^3 of timber harvested has declined by 23.5%, from 1.88 jobs/1,000m^3 (average 1984-1989), to 1.44 jobs/1,000m^3 in 1999 (Figure 32). In other words, the volume of timber cut per employee has increased substantially in a short period of time, and it now takes nearly 25% more wood to maintain one forest industry job than it did a decade ago.

The decline in employment per unit of biomass harvested may be due to increased mechanization and automation in both harvesting and processing, a trend explored in more detail in Chapter 9 of Volume 2, and a hypothesis that requires further investigation.

Figure 32. Forest Industry Employment Per Thousand Cubic Metres Harvested in Nova Scotia



Sources: Harvest volumes: NSDNR 1997a, NSDNR 1997b, NSDNR 2000c, K. Snow 2001. Employment data: Statistics Canada, Survey of Employment, Payroll and Hours, CANSIM database.

Note: For 1981-85, 1986-90, and 1991-95, average annual harvest data were available at publication time. These averages (3.3 million m^3 for 1981-85; 4.4 million m^3 for 1986-90; and 4.7 million m^3 for 1991-95) were used for each of the years within each range. For 1996-2000, annual harvest data were available for individual years.

Employment per unit of biomass harvested may also be related to the proportion of value-added manufacturing in the forest industry, since value-added production yields a high ratio of jobs per unit of wood harvested. Volume 2 of these accounts notes that Nova Scotia has one of the lowest rates of value-added manufacturing in wood products in the country, and it explores in some detail a case study that could provide a model for further development of this sector. Nova Scotia's rate of value-added is $82/m^3, compared to $273 in Ontario, $204 in Quebec, $187 in Manitoba, and $123 in New Brunswick (See Volume 2, Chapters 6 and 9).

Time and resources did not permit an examination of changes over time in the proportion of value-added manufacturing in the forest industry in this province, an indicator that would also provide important information on changes in employment per unit of biomass harvested.

Further investigation is also required into the availability of species on which value-added production depends. For example, long-term trends should be examined in order to determine whether there has been a decline in high value sawlog species and a consequent loss in the particular value-added industries that depend on high quality wood. Since these industries create a higher rate of employment per unit of biomass harvested than the growing pulp and paper industry, species availability can also affect this employment to biomass ratio.

Given the current low rate of value-added in Nova Scotia by comparison with other provinces, a strong recommendation of this study is the creation of incentives to support development of more value added manufacturing opportunities. The more value that is added to wood products within Nova Scotia, the greater the employment opportunities, and the greater the potential protection of the resource itself, since less wood has to be harvested for every dollar in value to the economy. From the GPI perspective, every extra dollar in value-added production increases the "interest" on the capital stock, and therefore enhances the economic viability of living off the interest without depleting the value of the province's natural capital assets.

In the GPI, therefore, an increase in employment per unit of biomass harvested is a sign of genuine progress, because it indicates both job opportunities and a potential increase in resource value. On the other hand, a continuation of the current trend may produce an increasing reliance on poorer quality stock with ever less value-added job creation potential, a downward spiral that serves neither the province's natural wealth nor the important goal of job creation. It portends a resource decline that may not be as dramatic as the sudden collapse of Atlantic ground-fish stocks, but nevertheless represents a significant gradual loss of value.

The potential economic value of a higher level of value-added production reinforces other evidence in this study indicating that the protection of non-timber forest values supports, rather than undermines, timber market values and long-term employment. Conversely, failing to recognize the linkages between ecological, social and economic well-being can lead to poorer quality forests with less potential for value-added production.

The almost complete loss of mature forests in Nova Scotia in the last 40 years, and the more gradual decline in natural species diversity and shade-tolerant hardwoods have already reduced the potential for value-added production in the wood industries by diminishing supplies of some high quality, high value timber. Chapter 7 shows that trees over 80 years old comprised 25% of forest cover in Nova Scotia in 1958, but only 1% by the end of the century, while Chapter 8 describes the loss of tolerant hardwoods and other species.

In sum, the employment statistics, resource statistics, clearcut rates, and changes in forest biodiversity cannot be seen in isolation, but must be related in order to assess the economic benefits of the forest industry to the Nova Scotia economy. The sharp increase in the area of forest being cut and the timber volume harvested, with the parallel decline in the workforce per unit harvested, shed a different light on the forest industry contribution than conventional assessments based on GDP value and employment alone. These trends also indicate a loss of potential in the creation of economically diverse industries that could add value to our wood products before they are shipped out of the province.

Table 12 demonstrates that more jobs, and higher skilled jobs, are created per unit of wood when value-added processing is developed in the economy (Abramowitz and Mattoon 1999).

Table 12. U.S. Employment Created by Various Timber Products

Logs to lumber	3 jobs per million board feet
Lumber to components (e.g. furniture parts)	Another 20 jobs per million board feet
Components to high-end consumer goods (e.g. furniture)	Another 80 jobs per million board feet

Source: Abramowitz and Mattoon, in State of the World 1999, Worldwatch Institute

Increasing the number of jobs per unit of resource is key to sustainable forestry practices and sustainable local economies. This "volume to value shift" has been recognized by some companies as a key to higher profits through producing higher-value products, rather than through increasing the volume of wood cut or processed (Abramowitz and Mattoon 1999). In the long run, forest workers and forest-dependent communities gain from this shift because jobs are more secure when the forest is sustained.

Government policy could therefore focus on both policies and incentives, firstly to maintain the ecological integrity of forests that is key to high value timber productivity and, secondly, to maximize the number of jobs per biomass unit. These incentives could support existing small-scale industry and encourage more local Nova Scotian manufacturing and value-added businesses, like that profiled in Chapter 6 of Volume 2 of these accounts. Such an investment could produce a win-win situation, with less wood needed to provide more jobs, and with more public and private revenues remaining in local communities and within the province.

It must be emphasized here that, although these forest accounts are created for Nova Scotia, there is no intention to single out Nova Scotia for blame here. On the contrary, the trends described here are global ones. Canada as a whole is the world's biggest timber exporter, but has seen the number of jobs per volume of biomass harvested fall by 20% in the last 20 years despite a substantial nationwide rise in harvest levels. In Sweden, too, about half of jobs in the forest products industry have been lost since 1980 during a period when production increased by more than 17% due largely to increased mechanization (Abramowitz and Mattoon, 1999).

It is precisely because Nova Scotia is no exception to these global trends, that a sustainable Nova Scotia alternative can literally have global appeal and create world-wide interest. Because a proper accounting and monitoring mechanism is key to such a shift to sustainable forest management, it is hoped that these forest accounts can contribute to and facilitate the necessary change. While the evidence in this first volume points to the clear need for such a shift, the case studies in the second volume describe the concrete methods already being employed by leaders in the field, indicating that the change is not only practical but economically viable.

12.4.2 Total employment in non-timber forest-related sectors

Provincial data are not yet available for this important indicator. Although tourism industry employment has been noted in the previous chapter, further research is required to assess the proportion of that employment related to nature tourism and forest recreation.

12.4.3 Forestry employment: hours, income, and injuries

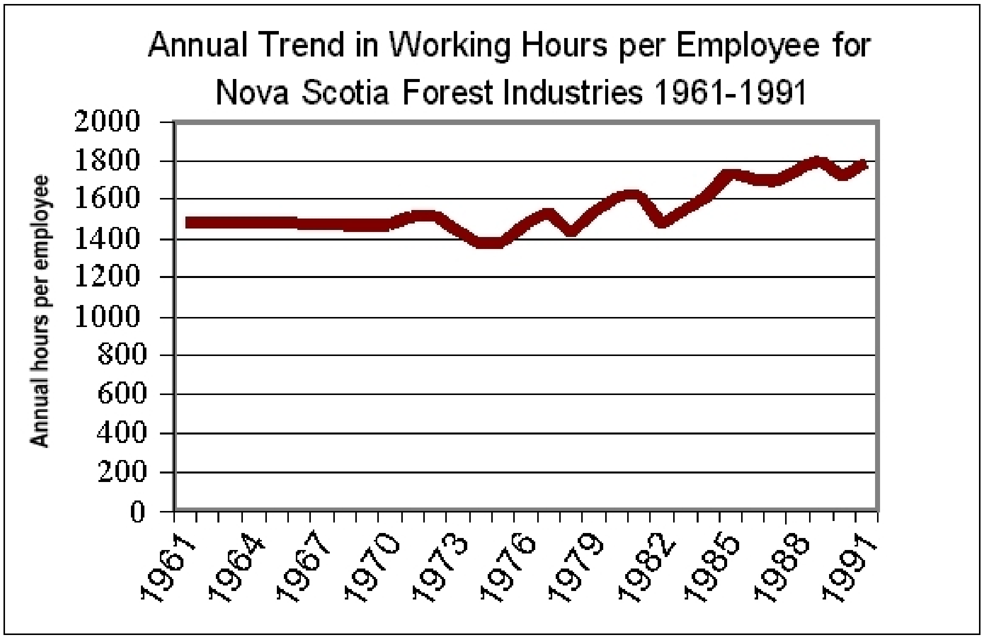
Working hours per forest industry employee have increased over time. In the 1960s and 1970s, the annual working hours per employee were between 1,400 and 1,500 per year. Since the early 1980s there has been a steady increase in hours worked, and by the early 1990s average annual hours were approximately 1,800 per employee, slightly above the current Canadian average of about 1,730 hours (Figure 33). This means that the average forestry worker in the early 1990s was putting in 20-25% more hours than 20 years earlier, the equivalent of about eight more full-time work weeks per year.

As with many other descriptive sections of these forest accounts, further investigation is required to explain the trends observed. Thus, if the increase in hours represents a shift from seasonal, part-time work to full-time employment, the trend may denote greater job security. If it represents higher rates of overtime and overwork, it may be part of the increasing polarization of work hours observed throughout the country in the 1990s, and may signify higher rates of stress and a decline in quality of life.

Chapter 9 of Volume 2, for example, indicates that high levels of indebtedness among logging contractors may help account for longer working hours in that segment of the industry. A need to work longer hours to make ends meet may also indicate declining livelihood security. Each of these hypotheses requires investigation, and it is the hope of GPI Atlantic that these forest accounts will spur needed research into many of these important issues.

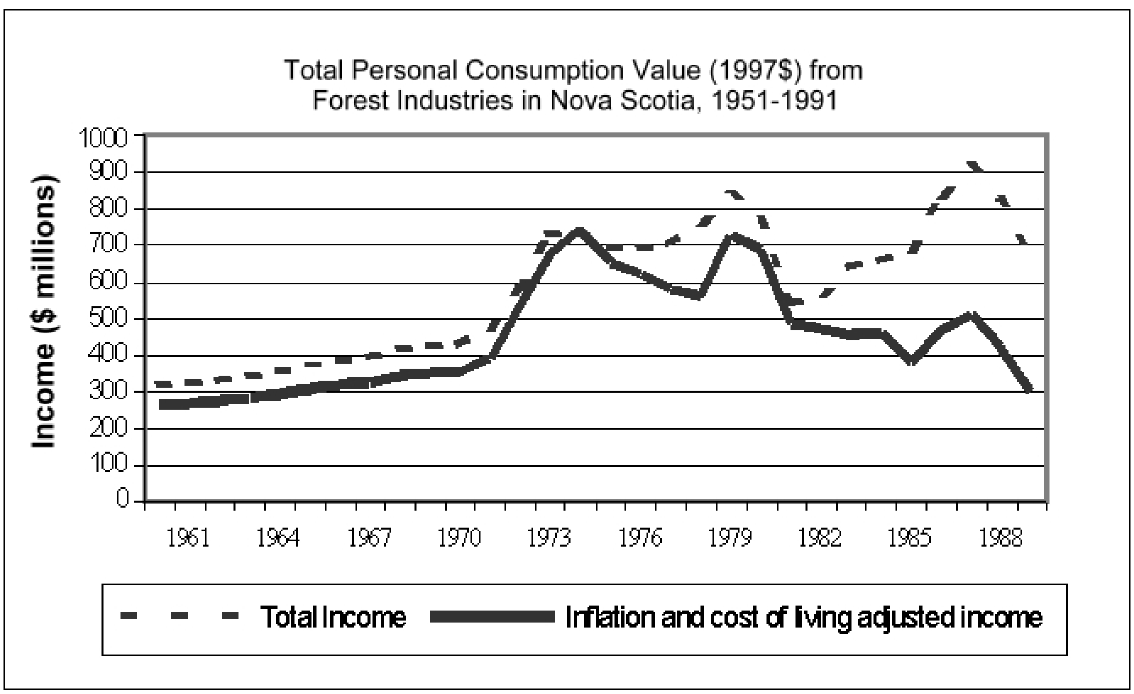
Another aspect of livelihood security is obviously income. Total personal income in current dollars for persons working in forest industries increased between 1961 and 1991. However, when this total personal income is adjusted to reflect the cost of living and inflation, there has been a steady decline in real income since the mid-1970s (Figure 34). That too could help explain longer working hours, as industry workers put in more hours as they strive to maintain their standard of living.

Figure 33. Annual Trend in Working Hours Per Employee for Nova Scotia Forest Industries, 1961-1991



Source: Selected Forest Statistics; MacAskill 1999.

Figure 34. Total Personal Consumption Value (1997$) from Forest Industries in Nova Scotia, 1951-1991



Source: MacAskill 1999.

Time and funding constraints did not permit the authors to update the work hour and real income figures to the present. But national trends in the 1990s point to steadily increasing work hours per employee and declining real wages in most industries up to about 1997. It is likely that these trends also hold true in the forest industries. Future updates of this report should also update the statistics in Figures 33 and 34.

Forestry has one of the highest occupational death and injury rates of any industry (Herbert et al. 2000); a cost paid for in large part by society, directly through hospital and medical bills, and indirectly in lost productivity. Health Canada's *Statistical Report on the Health of Canadians* reports the national rate of time-loss work injuries in logging and forestry as 82.4 per 1000 workers, the highest rate of any industry reported (Health Canada 1999). This is three times the average for all industries nation-wide, and more than four times the average for all industries in Nova Scotia. Further research is necessary to assess how many of the 7,940 total time-loss work injuries reported for Nova Scotia are attributable to forestry, and also to assess measures taken to reduce the high injury rate in the industry.[106]

A full-cost accounting approach to forestry would include such accident costs as losses, just as full-cost accounting procedures for transportation count accident costs in their cost-benefit analyses. Similarly, the GPI cost of crime report considered homicide, injury, and hospitalization costs due to crime as losses rather than gains to the economy. This seems obvious from a common-sense point of view but must be stated explicitly because the GPI approach differs markedly from conventional accounting procedures, which count accident and injury costs as contributions to the GDP, and therefore as economic growth simply because money is spent.

In short, considerations of sustainable employment include more than simply the numbers of jobs provided, but also the conditions of employment, including hours worked, real income, risk and danger. Future updates of this study could assess other conditions of employment in both the forest and tourism industries, including shift work, job security, benefits, contractual relations with employers, steadiness and continuity of work, and other considerations.

Aside from individual employment considerations, economic sustainability can also be considered collectively from the perspective of forest-dependent communities. Volume 2 of these accounts assesses the impact of alternative timber harvest practices on long-term employment prospects in forest-dependent communities, and indicates very different outcomes for clearcutting and selection harvest methods.

12.5 Other Timber Resource Indicators

Other timber value indicators that can be considered in future updates of this report, including both CCFM and Montreal Process indicators, are:

[106] Peter Woolaver, NSDNR, notes that increased mechanization (and capitalization) can enhance safety, while chain saw use will likely continue to produce injuries, which can be reduced through proper training and newer personal protective equipment. Time and resources did not permit an investigation here of the proportion of forest industry injuries attributable to chain saw use, and the proportion occurring in more mechanized operations.

1) The competitiveness of resource industries and their net profitability. This indicator would include an examination of the traditionally cyclical nature of Canada's forest sector. For example, 1992 registered net losses and 1994 registered net profits.
2) Tax revenues generated by the forest industries.
3) Employment in forest industries in relation to other economic sectors, to total provincial employment, and to employment in non-timber forest-related sectors (such as maple sugar products and ecotourism).

13. Uneven-Aged Woodlot Management & Value-Added Lumber Businesses

This Appendix provides a very brief overview for readers of Volume 1 of some selected examples of sustainable forest management at the small woodlot level. Readers are encouraged to consult Volume 2 of these accounts for more detailed analyses of some of these models, the methods they employ, and their economic viability. In addition, Volume 2 examines two large-scale industrial models of sustainable forest management.

It was precisely to demonstrate practical and viable ways forward that GPI Atlantic decided to expand this original brief overview into a more detailed second volume. Woodlot owners and forest industries will be able to use the models in that second volume for practical guidance, and government officials will find there detailed costs of restoration forestry that can indicate the scale of incentives required to encourage investments in the province's natural forested capital. For readers who will not explore these models in detail, the following summary at least provides some examples of best practices currently in existence.

13.1 Mel Ames, Maine: Low Impact Forestry

Several woodlot owners both in the Maritimes and the northeast United States have opted for sustainable long-term forest management planning on their own woodlots. For example, Mel Ames, a woodlot owner in Maine has been harvesting wood from his 600-acre woodlot since 1947 using low impact forestry and selection cutting. When he purchased the land, 50 years ago, it contained approximately 17 cords of wood per acre, and there are now approximately 35 cords of wood per acre.

In addition, Ames claims that low impact forestry (LIF) employs three times the number of loggers by volume harvested compared to mechanized high-grade and clearcutting operations. He also states from his experience that the higher quality wood from LIF can be used for products like furniture and lumber, which in turn requires considerably more workers than those needed for wood pulping. Moreover, he has found that the higher valued remaining forest provides even greater opportunities for other revenues and activities such as recreation, because the forest is more attractive to people and wildlife.

13.2 Finewood Flooring, Cape Breton: High Value-Added Wood Products

Value-added businesses employ a larger number of persons per unit of resource. For example, Finewood Flooring is one of the highest value-added wood product businesses on Cape Breton. Forty per cent of Finewood's finished flooring is sold within Nova Scotia, with the remaining 60 % exported to Europe (Italy, Germany, Austria, and France). For every 1,000 cubic metres of lumber processed, Finewood employs 10 people, whereas the pulp and paper industry sustains only 1.4 jobs is sustained for every 1,000 cubic metres of wood processed.

Finewood Flooring also adds 10 times more value per unit of wood than the local pulp mill. For example, pulp and paper revenues are approximately $118/cubic metre of wood, compared to Finewood's finished products, which can fetch CND $1,200/cubic metre in Canada and $1,600/cubic metre on the foreign market. In addition, just under half of Finewood's finished products are sold locally, thus doubling their value in local employment for the labour-intensive work of laying and finishing the floors. In other words, local sales produce far greater spin-off value and more jobs in the provincial economy per unit of biomass harvested than exports of raw product and of lumber,

Nevertheless, exports can also clearly benefit the provincial economy, although value is again gained in direct proportion to the degree of value added on site and prior to export. Finewood Flooring has recently expanded to take advantage of the growing European market for Nova Scotia hardwoods that derive from sustainably-managed forests. However, this expansion has run into difficulties that well illustrate the perverse incentives that currently dominate forest policy.

13.3 The Role of Incentives in Supporting Value-Added Manufacturing

Most of the Crown forest land in the Eastern part of the province is leased to Stora, a Swedish-owned multinational corporation that owns the local pulp mill. Because of that lease, Finewood has not been able to lease a sufficiently large forest tract to manage on a sustainable basis for hardwood sawlogs. However, recently there has been positive movement toward gaining access to hardwood on Crown land in the seven eastern counties. Stora Enso and the NSDNR would like to see hardwoods used more effectively, and Stora Enso is currently in the process of gaining certification for its woodlands. At this point, all of their decisions are confidential and sensitive.

Finewood also anticipates that current harvest practices in the area, driven by the requirements of the local pulp mill, could further diminish the available forest area that could potentially be suitable for its own products. Finewood has found that clearcutting converts the existing mixed and hardwood stands to even-aged softwood stands of fir and spruce that are only suitable for pulp. In addition, almost all provincial and federal investment is currently targeted to softwood production, a strategy that does not provide the best return to woodlot owners. Don George, a forester at Algonquin Park, notes that prices paid for hardwood saw logs at mills in Ontario, New Brunswick, and Maine, indicate that selective management of hardwoods actually gives the highest return to woodlot owners.

Access to high quality lumber for value-added production is, therefore, a major problem for harvesters, small and medium-sized sawmillers, and wood product manufacturers. For example, B.A. Fraser Lumber and Finewood Flooring jointly proposed a selection harvesting plan for lease of Crown forest land in Cape Breton, but were unable to access crown lands in the seven eastern counties because they are leased to Stora.

Additionally, access to private lands has been hampered in the past by the structure of financial incentives. Until very recently, subsidies for silvicultural treatments conducive to pulp wood production encouraged small woodlot owners to convert healthy mixed forests to pulp stands. A 1997 National Round Table on the Environment and the Economy report on Maritime woodlots noted that the structure of financial incentives and penalties at that time literally encouraged unsustainable harvest practices (NRTEE 1997).

In order for sustainable forest practices to prosper, equitable silvicultural incentives are needed that allow woodlot owners to manage forests selectively for shade-tolerant hardwoods. These incentives are needed to cover the costs of roads and initial stand improvement cuts that often require leaving low quality wood on the ground. There will always be a small and stalwart band of sustainable forestry practitioners. But, for these practices to enter the mainstream and provide more general protection for Nova Scotia's forests and natural wealth, government clearly has an important role.

Fortunately, the new NSDNR Forest Sustainability Regulations for the first time provide silviculture credits for selection harvesting roughly on a par with those for conventional clearcutting-silviculture methods. Thus, a major disincentive to selection harvesting has finally been removed, and the five-year review of those credits could potentially create actual advantages to wood lot owners willing to manage on a sustainable basis for hardwood sawlogs.

Further reforms are needed to encourage selection management for tolerant hardwoods. The current structure of public management expenditures, lease agreements, and subsidies still support a conventional industry structure highly dependent on clearcutting and on pulp and paper processing. As noted earlier, pulp and paper now accounts for more than two-thirds of the forest industry contribution to provincial GDP, up from 50% a decade ago.

We have noted that this trend is questionable from an *economic* point of view as well as an ecological one. Current policies, leases, subsidies, and management expenditures support less jobs per cubic metre of wood harvested and per dollar invested than would be yielded by support of the Finewood Flooring expansion and similar investments in value-added manufacturing.

If the full range of forest values is considered in a cost-benefit analysis of current subsidies, then they might be seen not as an "investment" but rather a disinvestment in a healthy high-value forest sector. By contrast, incentives that supported the maintenance of forest ecosystem functions would produce additional indirect, long-term gains in value beyond the immediate economic benefits of job creation in sustainable forestry industries.

So long as the full range of forest values is not considered in provincial resource accounting practices, it will be very difficult to reorient the existing structure of policies, incentives, and penalties decisively in such a way as to encourage sustainable forestry practices on a province-wide basis. These GPI forest accounts are not just a theoretical exercise. They are intended as a practical accounting step that will be the basis of a structure of incentives that will allow Fraser Lumber, Finewood Flooring, and other sustainable forestry practitioners to establish viable enterprises, expand their operations, and access the high quality product they need while protecting Nova Scotia forests. Their success, in turn, will provide a model for other woodlot owners and industries.

13.4 Windhorse Farm, New Germany: Steady Supply, Quality and Value-Added

Jim Drescher of Windhorse Farm owns a 60 hectare woodlot of which approximately 55 hectares are operable forest land. Of this, 36 hectares were first selectively logged in 1840 and have been sustainably managed ever since, based on ecological principles. The remaining 19 hectares of forest land had been cleared for pasture land and are now being restored. In 1840, the woodlot contained 2 million board feet of wood, and today this volume remains undiminished.

Each year for the past 161 years, more than 50,000 board feet of timber have been harvested from the Windhorse Farm woodlot. This represents 50% of the annual growth increment of 100,000 board feet, or 2.5% of the total standing stock. In recent years, the harvest has been about 60,000 board feet, although Drescher has now cut this in half in order to increase the deadwood component on his woodlot. In total, more than 8 million board feet have been harvested over this 161-year time period with no loss in the overall standing volume or in the quality of soil, lumber, wildlife habitat, or other forest values. This type of woodlot management ensures a steady annual income for the woodlot owners and ongoing job security for local community members who work on woodlots.

If the woodlot had been clearcut, 2 million board feet would have been extracted in1840. With repeated clearcuts every 50 years of an estimated 1.25 million board feet (calculations based on mean annual increments of natural regeneration) through 1990, a total of only 5.75 million board feet could have been harvested to the present time. In addition, the value of the current forest would now be essentially zero, given the fact that there would be no merchantable wood present on the woodlot as a result of the latest 1990 clearcut.

The actual total harvested through selective methods (more than 8 million board feet) over 161 years, plus the current undiminished volume of healthy, standing timber on the woodlot (2 million board feet) gives a total volume of more than 10 million board feet of timber harvested and remaining on the woodlot. This is nearly twice the timber volume that would have been obtained from the woodlot if it had been clearcut every 50 years.

That simple calculation does not consider the additional decrements in forest value due to loss of biodiversity, habitat, soil quality, and other forest values, nor the comparative quality and market value of wood harvested in successive clearcuts, compared to that obtained through selection methods. In addition, the clear-cut operations would have provided no ongoing job security to local harvesters working the woodlot, as the work would have dried up as soon as the clearcut was completed.

In other words, a sustainable selection harvesting approach actually yields significantly higher long-term yields in terms of board-feet of timber harvested, while protecting the full range of forest values and quality, and providing long-term sustainable employment to local harvesters.

These calculations are obviously simplified and do not take into account the cost of silvicultural inputs following clearcutting, that would have produced additional expenses to the woodlot owner, nor the potential degradation of the forest and soil quality after successive clearcuts. The equation also does not consider the frequent problems encountered with attempted regeneration following repeated clearcutting, and sufficient restocking both of the quantity and quality of wood.

In addition, as noted, the equation does not consider the comparative market price of the selectively harvested and clearcut wood, but counts only the number of board feet harvested. In fact, the quality of the wood grown continually under a forest canopy, rather than in a clearcut, has a considerably greater financial return, as demonstrated in Volume 2, Chapter 8. The selectively harvested wood yields a higher proportion of clear (rather than knotty) lumber and large diameter wood than are obtainable in 50-year successive clearcuts. Large diameter and clear wood both fetch premium market prices. Selection harvesting can also maintain the presence of valuable species, some of which are currently in decline in Nova Scotia (Chapter 7).

If the higher revenues obtainable for large-dimension, clear, and tightly knotted wood present on the woodlot, as well as for valuable species fetching premium market prices, were included in the equation, the comparative economic advantage of selection harvesting could be considerably greater over the long term (see below).

In sum, when other elements of revenue and cost are included, the long-term financial viability of sustainable harvest practices becomes even more convincing than the simple quantitative calculation of additional board feet produced through selection harvesting. Certainly a full-cost accounting assessment of comparative harvest methods would support Drescher's argument even more fully, as the value of non-timber assets maintained and protected through the ecological harvest methods practiced at Windhorse Farm for 160 years would show substantial qualitative benefits over clearcut methods.

13.5 Market Value of Canopy-Grown Wood versus Open-grown Wood

This subject is explored in more detail in Volume 2, Chapter 8. A summary of initial findings follows here. GPI Atlantic recognizes that more detailed marketing studies are necessary on this subject, including estimates of potential demand curves in relation to availability of supply.[107]

The quality of wood is generally reflected in the market price of different types of lumber. For example, diameter, size, and clear wood (as opposed to knotty wood) are indicators of quality.

[107] Eldon Gunn, personal communication, November, 2001, notes that any “market study usually attempts to identify a demand curve p(V) which is price at which a given volume can be sold. These curves are inevitably downward sloping so that there can be a tremendous difference between the highest price consumers are willing to pay for the commodity, the average price and the marginal price of the last item demanded.” Further exploration of the potential demand for large diameter and clear wood should definitely involve such a full market study.

Large diameter wood is worth considerably more per cubic metre than narrow gauge and thin lumber. Large dimension wood of 11.5 to 13 inch dimensions can regularly be found on a selectively logged woodlot. Windhorse Farm's 55 hectares have 20-25% large diameter tree size capable of yielding premium width boards, and 15-20% clear wood. When the presence of valuable species natural to the original Acadian forest are included, fully one-half of the Windhorse Farm wood harvest fetches premium market prices.

By contrast, openly-grown trees in a clearcut grow quickly and do not self-prune. Due to the light they receive in the more open environment, the lower branches of these trees do not die, and they therefore tend to have larger, looser knots. This difference has market implications. Clear wood is worth two to four times the value of knotty wood. Clear board red spruce, for example, fetches $1.70 to $2.70/ board foot compared to knotty red spruce which fetches only $0.60/board foot. Hemlock knotty lumber is even less desirable.

In other words, per unit of biomass harvested, there is a considerably larger return on investment from a multi-species, multi-aged woodlot (i.e. uneven-aged forest management) due to its much larger range of high-value products, by comparison with an even-aged woodlot that generally produces only for pulp and paper mills. In addition, it is more economically efficient to be logging larger logs than smaller logs because the same amount of effort is needed to log the trees out while the output is of considerably higher value.

No attempt has been made in this study to aggregate the full value of Nova Scotia's forests, beyond the illustrative extrapolation from Costanza's global figures on forest ecosystem values in Chapter 11, because sufficient data are not currently available to do so. Nor has it been possible to estimate the full loss of value resulting from the degradation of the forest stock over time.

However the comparative market prices given here, and the Windhorse Farm data on the percentage of wood from a sustainably logged multi-species multi-aged forest fetching premium prices, allow a further illustrative extrapolation here. Nova Scotia forests vary widely, and no claim can be made that the Windhorse Farm soils, species composition, and other conditions apply to the rest of Nova Scotia, even if forests were still in their natural state.

Despite this disclaimer, let us assume for a moment that Nova Scotia forests were still in their natural state, or at least had been consistently logged sustainably, and apply the Windhorse Farm data to Nova Scotia forests for illustrative purposes only. Let us also assume that each of the 2.6 million hectares of operable forested land in the province contains 40,000 board feet of wood, just like Windhorse Farm, and that 1% of the standing stock is harvested annually. If one-half of that harvest fetched a premium price of $1.70 per board foot, it would be worth $900 million. At the knotty spruce price of 60 cents a board foot, it would be worth $312 million, a loss of value of $588 million annually.

While this is only an exercise in imagination and omits many important elements in the equation, it nevertheless serves to illustrate the enormous magnitude of market value potentially lost from the conversion of Nova Scotia older natural forests to young, even-aged stands. In timber value alone, the value of the natural capital stock has plummeted since historical times, even without consideration of the non-timber value of the province's forests.

Applying this illustration to actual Nova Scotia forest inventory data, we know (Figure 5) that trees over 80 years old covered 25% of Nova Scotia's forested land as recently as 1958. Certainly a good portion of those old trees would have yielded clear, large diameter lumber at premium prices. If 3% of those mature forests were harvested annually, in line with annual Windhorse Farm harvest rates, and just 30% of the harvest fetched a premium price of $1.70 a board foot, that high-value lumber would be worth $400 million. Forty years later, with old trees covering just 1% of Nova Scotia's forest land, and with little clear, large diameter wood left in the province, the loss of potential market value represented by the same harvest fetching only 60 cents a board foot would be $260 million annually.

While no claim at all can be made for the provincial numbers derived from the overly simple Windhorse Farm illustration, the illustration nevertheless indicates that Nova Scotia forests are contributing very much less to the provincial economy than they would be if they had been managed sustainably.

The case for sustainable forest management and selection harvesting has often been made from the environmental perspective. It can now confidently be made from the economic perspective as well. The evidence is convincing that, far from being in opposition to economic gain, sustainable forest management that protects forest ecosystem values enhances the economic value of the resource and contributes to prosperity and employment.

13.6 Economic Viability/Resilience

An important factor contributing to economic stability is the ability to sustain a woodlot business during market fluctuations, because wood product prices tend to fluctuate considerably over time. Jim Drescher of Windhorse Farm believes that diversity is a critical factor for economic viability because it makes the woodlot owner less dependent on one commodity, and allows him to market different grades and species of timber according to market conditions in different years. For example, if pulp and paper prices drop dramatically, building material prices may well remain more stable. “Diversity brings greater stability to a business, increases the probability of economic viability and reduces the probability of market catastrophe,” says Drescher.

Further, an independent harvester operator who contracts his time and equipment to large companies like Bowater, Irving, or Stora on successive clearcuts faces other economic challenges. The operator owns his own equipment and with this investment comes debt, job insecurity, and the adverse social impacts of moving from contract to contract and place to place. Because the operator is under contract, he is without steady employment or job security. A harvester, on average, lasts about 5 years before it will need to be replaced, and it is not always certain that the equipment debt will be repaid within that time span. By contrast, selection harvesting provides steady year to year employment on the same piece of land for local workers who live and remain within their own communities. The economic impacts of mechanization in the forest industry are explored in more detail in Volume 2, Chapter 9.

The economic viability of Windhorse Farm and its contribution to the provincial economy are also ensured through other types of value-added industry. Windhorse Farm processes its own wood and has a woodworking shop where raw lumber is converted to finished building materials. That processing, woodworking, and finishing provides additional jobs to local community members. The enterprise also brings in additional income through woodlot tours, wagon and sleigh rides, and other activities.

Windhorse Farm is also the site of the Maritime School of Ecoforestry that each year attracts dozens of forestry students from throughout Canada and the United States. The accommodation, travel, food, and other provincial expenditures of these students provide significant indirect spin-off benefits to the Nova Scotia economy. In short, because of its varied on-site value-added products and services, Windhorse Farm provides significant direct and indirect benefits to the provincial economy. On a hectare by hectare basis, and in proportion to the volume of biomass harvested, these benefits far exceed those that derive from simple clearcut logging for the pulp and paper industry.

If Nova Scotia as a whole followed some of the models that already exist in the province, and if it made a commitment to sustainable forest practices, it could literally become a "showcase" for the country and the world. The province could provide a training ground that would attract students from far afield, yielding significant benefits to the provincial economy.

13.7 Hidden Costs of Large-scale Harvesting and Large-scale Mills

From a full-cost accounting perspective, sustainably managed woodlots may also be more efficient than large-scale clearcutting and industrial milling, because they contain less hidden, external costs. The three fundamental principles of full-cost accounting are that external costs should be internalized, that fixed costs should be variable (e.g. with energy use), and that non-market values be counted along with standard market values. These principles literally promote efficiency by encouraging conservation, reducing waste, and ensuring that producers and consumers pay the full cost of the product.

There are many hidden, external costs that accompany large-scale clearcutting and milling operations. The most obvious is the loss of jobs per unit of biomass harvested due to increased mechanization, as noted in Chapter 12 of Volume 1, and in Chapters 8 and 9 of Volume 2. Each harvester, for example, replaces 13 to 15 jobs. Furthermore, clearcuts can leave forest-dependent communities stranded when the resource suddenly disappears, while selection harvesting can provide steady year-round employment for local communities.

The costs of this job replacement and job loss are borne by society as a whole in a reduced tax base, increased employment insurance and social welfare costs, and a wide range of indirect health, justice and other costs. The authors did not have the opportunity to search for sociological studies examining the impact of job losses specifically due to forest industry mechanization or harvest methods, but these costs should be considered in future updates of this study.

In addition, there are other hidden costs to large-scale clearcutting and milling operations, including the costs of transportation and fossil fuel use. Commuting to work and moving harvesters from one clearcut to the next carries hidden transportation costs that are not incurred when local community members work in woodlots in their own communities on an ongoing basis. Large industry operations also produce hidden social costs through the transportation of logs from each logging area to the major mills in heavy logging trucks, which in turn produces road damage costs borne by the public. These transportation costs are explored in more detail in Chapter 9 of Volume 2.

These examples simply illustrate that any economic assessment of the viability of small, sustainably managed woodlots compared to the large-scale industrial forestry norm must take into account such hidden costs and subsidies in any evaluation of comparative efficiency and cost-effectiveness. Volume 2 of these accounts does explore two large-scale industrial forestry operations that have successfully combined the efficiencies and economies of scale of large enterprises with the principles of sustainable forest management and selection harvesting. The comparison here therefore refers specifically to the conventional industrial forestry norm existing in Nova Scotia today.

13.8 Restoration Forestry

In addition to the 55 hectares of forest land that he owns, and of which 36 have been sustainably harvested for 161 years, Jim Drescher of Windhorse Farm manages other woodlots that are in various stages of restoration. Although trees have regenerated and grown on these sites, they still require considerable restoration work. Drescher is investing in this restoration with no financial return even though the work is gradually increasing the non-market and ecological values of these forests by restoring habitat, increasing carbon storage and providing other public benefits. Eventually that site will also yield considerable higher timber values.

Most of Nova Scotia's forests are badly in need of restoration, but few woodlot owners can afford to make the necessary investment without any financial return. Incentives have historically existed to clearcut and then replant, primarily to provide more timber output for the pulp and paper industry in successive clearcuts, but such incentives have not existed for actual restoration work that may not produce a viable timber yield for 100 years. To encourage woodlot owners to undertake restorative work, economic incentives must be put in place that are commensurate with actual restoration costs, and are based on the criterion of improving Nova Scotia's forest quality and the ecological values of forested land. Volume 2 attempts to quantify this restoration investment on a per hectare basis.

This approach requires a long-term view because the pay-off will be beyond the lifetimes of those making the investment. Given the long history of degradation, investments in restoring the province's natural wealth are now needed that will benefit our grand-children and their children. This restorative work must be accompanied by some kind of moratorium on "business as usual" practices. If current trends continue, like the two-fold increase in clearcutting in the 1990s, it is likely that Nova Scotia's forests will be further degraded, and the province's natural wealth may be diminished to the point of no return.

To that end, Dr. Bill Freedman of Dalhousie University's Biology Department has suggested "50% less harvesting than we have today," with "50% of the working forest…comprised of selection harvesting systems," and "the other 50% of more intensive management including the use of plantations restricted to native species of trees."[108] In effect, Dr. Freedman's recommendation means that existing even-aged management systems might be frankly designated as "tree farms" rather than "forests" and would continue to supply the pulp and paper industries, while efforts were made to restore potential forests to their natural state.

The 50% harvesting cut would be analogous to the moratorium in the cod-fishery that was also required in order to build up capital stocks and restore resource health. Drescher argues that such a 50% cut in clearcutting would not reduce forest industry employment but could actually double forest industry employment with a switch to more labour-intensive selection harvesting techniques.

To take the long-term view necessary for restorative investments, it must be recognized that excess benefits and revenues have already been derived from most of the province's forests at the expense of an actual decline both in the quantity and quality of the capital stock. As in any business, the value of the capital stock must be restored through re-investment if the enterprise is to remain viable. This means that the costs of past forest cutting, forest depreciation, and neglect of capital stock, will now have to be paid if forests are to be productive in the future.

Restorative forestry measures are now necessary to compensate for past practices in much the same way that excessive deficit spending in the past now requires responsible governance and fiscal prudence to restore financial health in the public sector. It will take a long time to pay down the enormous national and provincial debt accumulation that have resulted from past over-spending, so the necessary sacrifices and investment to achieve that goal also require a long-term view. Nova Scotia's forests are so far "in the red," and the debt in lost ecosystem services and forest productivity so massive, that it will also take generations to restore a healthy balance sheet.

As woodlot owners will not themselves reap the financial benefits of this restorative forest work, and since the work will yield significant public benefits to future generations of Nova Scotians, it is unreasonable to expect woodlot owners to carry the present costs of restoration work on their own shoulders. A few foresters, like Jim Drescher and the newly FSC-certified Pictou Landing foresters will undertake that work in any case. But it is not realistic to expect the majority of Nova Scotia woodlot owners to make the necessary investment at considerable cost and effort on their own part and without financial return.

The following four concrete policy steps are therefore necessary to begin restoring Nova Scotia's natural forest wealth:

- Financial incentives must be incorporated in our taxation system to enable woodlot owners to undertake restoration efforts that will not yield short-term financial returns but will provide long-term public benefit.

[108] Dr. Bill Freedman, 1998, at a public forum on Nova Scotia forest practices, Dalhousie University, Halifax.

In addition, it is necessary to take precautionary measures to avoid a similar degradation of forested natural capital in the future. To that end:

- The full costs and benefits of forests and of associated harvest methods must be counted and included in present-day forest management planning.
- A reduction in the rate and quantity of timber harvested must accompany active re-investment in the restoration of natural capital values.
- Finally, harvesting methods need to be changed to protect a larger range of ecosystem services, benefits and capital (below).

13.9 Harvesting practices that maintain ecological services and integrity

The fundamental principle of ecologically-based forestry is the harvesting of wood in such a way that it does not detrimentally affect the ecological systems and services provided by forests, and the full range of functions performed by forests. Eco-forestry aims to maintain both the market and the ecological values of the woodlot, and recognizes that the former are dependent on and enhanced by the latter. The following ecological services and functions should all be considered and properly accounted for in practical forest management, just as they should be included in the provincial forest accounts:

- raw wood supply
- climate regulation, including carbon sequesteration
- disturbance regulation, such as prevention of extreme blow-down
- water cycle
- water supply and purification
- erosion control, including prevention of sediment loss and leaching of nutrients
- soil formation (e.g. litter fall)
- nutrient cycling
- waste treatment
- biological control (i.e. insects)
- habitat
- pollination
- food production, including mushrooms, berries and nuts
- supply of medicinal plants and herbs
- genetic resources (i.e. genetic pool)
- cultural enhancement, including recreation and spiritual associations

13.10 Summary of uneven-aged management

It is widely recognized and acknowledged that skilful, uneven-aged management and selection harvesting can successfully protect the full range of forest values, while providing an economically viable and sustainable timber supply in the following basic ways:

1) Forest canopy-grown trees versus openly-grown trees tend to have clearer wood as a result of self-pruning. Clearer wood means higher quality wood and premium prices. Maintaining a forest cover protects a woodlot's natural capital including soil quality, water flow, and other ecological services and benefits. Large diameter wood per board foot provides higher financial returns.
2) Harvesting in an ecological manner also provides on-going opportunities for other forest-related activities and functions. For example, Windhorse Farm provides training through an internship programme, woodlot tours, wagon/sleigh rides, one-week courses in ecologically-based harvesting methods, and organic farming workshops. Recreational opportunities provide another income possibility for woodlot owners, including hiking, bird-watching, snow-shoeing, and cross-country skiing. The maintenance of a forested woodlot and an ecologically diverse ecosystem will attract both people and wildlife.
3) A diverse forest will provide continuous income and employment for local communities, and prevent business collapse when market prices dip.

The purpose of this brief summary, and of the more detailed case studies of sustainable forest practices in Volume 2, is simply to demonstrate that there are already existing working alternatives in the province and beyond that can show a sustainable way forward. These examples provide practical working models of practices that can begin to restore the province's natural forested wealth for the benefit of future generations.

14. Conclusions

The evidence presented in this study demonstrates the direct and intimate links between ecosystem and timber values, and the direct dependence of long-term timber productivity and timber value on forest ecosystem integrity, including natural species diversity, age structure and composition, soil quality, watershed protection, and other qualitative indicators. The CCFM and Montreal Process criteria and indicators of sustainable forest management clearly recognize that linkage.

In short, assessments of the value of forest ecosystem services alongside the value of timber contributions should not be taken to exacerbate the industry-environmentalist divide. On the contrary, the linkages between ecosystem health and timber productivity noted in this study indicate that valuing and strengthening the economic contribution of forest ecosystem services also enhances timber values. The restoration and maintenance of forest health, integrity, and quality not only has an ecological purpose, but is also essential for the long-term viability of the forest industry in Nova Scotia, which depends on healthy forests.

The trends presented in this study indicate that current forestry practices in Nova Scotia are unsustainable, both ecologically and economically. Valuable natural assets are being rapidly depleted without accounting either for the public and externalized costs or for the long-term quality and sustainability of the province's wood supply. Increased harvest levels in the present can temporarily increase the forest industry's contribution to GDP. But they mask the fact that future generations of Nova Scotians will bear the brunt of current unsustainable practices, and will inherit a poorer legacy of natural wealth as the result of current practices.

The value of the province's forests has been degraded by more than two centuries of land clearing, high-grading, and clearcutting, and best forest restoration practices are needed to restore the natural forest wealth that Nova Scotians inherited generations ago. In this study, the most dramatic indicator of the qualitative change in Nova Scotia's forests has emerged as the change in age structure. In the last 40 years alone, we have seen that the province has lost virtually all its remaining old age-class forests, down to 1% today from 25% of forest area in 1958, with only scattered remnants of the original old-growth forests remaining.

It is tempting to "write off" the past loss in value in the province's forests, and to take the present forest structure as the norm, the way we have written off the cod fishery and simply switched our efforts to harvesting other marine species. Indeed, conventional analyses of the forest industry rarely, if ever, relate its present value to its potential value based on the structure of the original Acadian forest, but rest instead on the implicit assumption that the present forest structure is normal.

And yet, there are remarkable examples of a way forward that do not accept that premise, but recognize the full potential of Nova Scotia's forested wealth. Volume 2 details case studies that demonstrate sustainable forest practices and restoration efforts. These practices are designed to protect the full range of forest values, and they are based on scientific understanding of the intimate connection between forest ecosystem health and integrity on the one hand, and timber productivity on the other.

More than that, these working models, that rely on selection harvesting and other low-impact management methods, are already demonstrating their long-term economic viability, even in the absence of past supports and incentives available to clearcut-silviculture harvesters. They are providing more jobs per unit of biomass harvested than the conventional forest industry; they are harvesting high-value timber; and they are demonstrating the profitability of value-added wood industries that produce a remarkably high value per unit of biomass harvested.

For the first time, the NSDNR's new silviculture credits have removed previous disincentives to sustainable harvest methods by recognizing selection harvest methods, so that a larger number of woodlot owners may begin to express interest in the models described in Volume 2 of these accounts. In short, Nova Scotia may be on the cusp of a major change in forest management that, with vision and political will, could establish the province as a world leader in restoring the value of natural forested wealth.

The social and public benefit these models provide to present and future generations of Nova Scotians merit support in the form of stronger financial incentives to encourage other woodlot owners and industries to follow suit. The removal of disincentives, and the placing of selection harvesting on an equal footing with clearcutting in the new silviculture credit system, is an important first step over past practices. But the first five-year review of these credits could adjust the credit system to create actual incentives to woodlot owners to switch from current practices to more sustainable management methods.

A note should be added here on the use of incentives, as the issue is too often framed as a blanket argument on whether subsidies to industry per se are justified or not. There is a major difference between subsidies that send the wrong fiscal message by encouraging established industries to continue activities that have already proven costly in environmental degradation, and incentives that change behaviour and enable industries to make transitions to more environmentally benign practices. Ecological fiscal reform rewards behaviours that avoid social costs, and provide long-term benefits to society. The taxation credit system is already used to reward and encourage particular behaviours. It can also be used to protect the health of our natural resources, in proportion to the social benefit created.

While Chapter 13 of this volume provides a brief overview of examples of sustainable forest management on small woodlots, Volume 2 describes these working models in considerably more detail and also points to models of sustainable practices on the large industrial scale. Those models will only enter the mainstream when restoration forestry is regarded as an investment rather than a cost (as it still is), and when the full range of forest values is both the measure of forest health and integrity, and the basis of public policy.

Because it employs full-cost accounting methods, the Genuine Progress Index inevitably points to hidden costs that have not been recognized in the conventional accounts. This may initially be interpreted as "bad news," when a decline in natural capital value is documented. However, the purpose of the GPI is certainly not to create a climate of blame and despair. On the contrary, the exposure of hidden social, environmental and economic costs should be interpreted as very good news, because it points to actions that can restore the value of hidden assets that have not been properly counted and appreciated as part of the province's natural wealth. The purpose of the GPI is entirely to indicate ways forward based on the shared values of all Nova Scotians.

Indeed, one reason that there is real hope for the future is precisely in the availability of new forest accounting procedures that will enable a more comprehensive physical, ecological, social, and economic measure of forests. A primary reason that the long decline of Nova Scotia forests has gone un-chronicled and without remedial action, is simply that it has not been tracked with a set of comprehensive measures.

Just as the reliance on gross market revenues and GDP statistics to describe the forest industry has produced perverse financial incentives that have encouraged unsustainable harvesting practices, so that misuse of market statistics has sent misleading messages to policy makers, foresters and the general public. The availability of more comprehensive measures of forest quality, integrity, and health, to which this set of forest accounts is one contribution, will enable Nova Scotians to see clearly the true costs of forest decline, the benefits of remedial action, and the value of restoration forestry.

These accounts are simply a preliminary first step in that process, and it is clear that considerable further research is required to fill out the many data gaps that still exist. GPI Atlantic welcomes improvements in methodologies, data sources, and interpretation of results that can improve these accounts, and render them an ever more useful policy tool. At the same time, these data gaps and needs are no reason for inaction. There is sufficient evidence in these two volumes to provide clear guides for forward movement that can begin to restore the value of Nova Scotia's natural forested wealth and capital assets without delay.

15. Recommendations

To protect and restore the value of Nova Scotia's forest wealth and the full range of forest services, the Nova Scotia GPI Forest Accounts study recommends:

- greater incentives for investment in forest restoration and uneven-aged management, including selection harvesting, in order to protect and restore the natural age distribution and species diversity of the province's forests, and to provide more jobs;

- a sharp reduction in the rate of clearcutting and the volume of timber harvested annually;

- a gradual industrial shift from volume-based to value-added forest products, to produce high-value wood products, and to increase the number of jobs per unit of resource harvested;

- protection of all remaining old-growth forest;

- monitoring the full range of forest values and services, and the full cost and benefits of associated harvest methods, to be counted and tracked in annual forest accounts and in ongoing forest management planning;

- an adequate network of representative protected areas in Nova Scotia.

Such policies and incentives, which promote forestry practices that maintain high-quality and high-value species, will benefit the economy as much as the environment. Encouraging wood industries that add value to wood products can create jobs at the same time that they prevent resource depletion, by generating the greatest amount of employment for every cubic metre of timber cut in the province.

Given the high rate of private ownership of operable forest land in Nova Scotia, government policy will have to focus as much on incentives as on policy and regulation, both to maintain ecological integrity and to maximize the number of jobs per biomass unit. Incentives can also be a more palatable method of encouraging the development of more small-scale wood product industries and local Nova Scotian manufacturing and value-added enterprises. This can create a win-win situation with less wood needed to provide more jobs, and with more public and private revenues remaining in local communities and within the province.

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APPENDIX A
WILLINGNESS TO PAY TO CONSERVE BIODIVERSITY

Section 11.4 on the Economic Value of Protected Areas refers to a study by Adamowicz et. al. surveying published reports that assess the willingness of individuals to pay to preserve particular species and habitats. Table 1 below contains samples from these published results:

Table 13. Compilation of Published Results Indicating the Willingness to Pay to Conserve Biodiversity

Species and habitats	US 1990 $ p.a. per person
Norway:	
Brown bear, wolf and wolverine	15.0
U.S.A.	
Bald eagle	12.4
Emerald shiner	4.5
Grizzly bear	18.5
Bighorn sheep	8.6
Whooping crane	1.2
Blue whale	9.3
Bottlenose dolphin	7.0
California sea otter	8.1
Northern elephant seal	8.1
Humpback whales	40-64
Grand Canyon (visibility)	27.0
Colorado wilderness	9.3-21.2
Australia:	
Nadgee Nature Reserve NSW	
Kakadu Conservation Zone, NT (two scenarios of	28.1
mining development damage were given to	40.0 (minor damage)
respondents)	93.0 (major damage)
UK:	40.0
Nature Reserves (survey of informed	
Individuals only)	
Norway:	59.0-107.0
Conservation of rivers against hydroelectric	
development	

Source: Adamowicz et. al. 1996

Section 11.4 refers to another willingness-to-pay study by Adamowicz and Condon (1997) in a Newfoundland conservation area that found that the benefits of Pine Marten conservation would exceed the net social value of timber harvested. Table 2 below summarizes the results described in Section 11.4

Table 14. Willingness to Pay for Pine Marten Conservation in Newfoundland compared to Net Social Value of Timber Harvested

(a) Value of the American Marten to Newfoundland residents ($Cdn1992).

American Marten and habitat	Mean	Median
Willingness to pay (WTP)	$28.38	$4.05
Aggregate Annual Value	$10,430,757	$1,488,533

Note: The mean WTP is the expected value of the WTP distribution, and the median WTP represents the size of bid at which 50% of the sample would be willing to say yes to the payment. The annual value is aggregated over all residents of Newfoundland.

(b) Value of harvested timber to Newfoundland residents ($Cdn1992).

Harvest Value of Timber	Net social value	Residual harvest
Value per cubic metre	$20.60	$15.25
Annual value	$1,300,000	$1,000,000

Note: The annual value is calculated using a study by Milne (1988) that estimated the annual harvest at 65,000 cubic metres.

APPENDIX B
THE NOVA SCOTIA GENUINE PROGRESS INDEX: LIST OF COMPONENTS

TIME USE:

* Economic Value of Civic and Voluntary Work
* Economic Value of Unpaid Housework and Childcare
* Hours of Work
* Value of Leisure Time

NATURAL CAPITAL:

* Soils and Agriculture
* Forests
* Marine Environment/Fisheries
* Nonrenewable Subsoil Assets

ENVIRONMENT:

* Greenhouse Gas Emissions
* Sustainable Transportation
* Ecological Footprint Analysis
* Air Quality
* Water Quality
* Solid Waste

SOCIOECONOMIC:

* Income Distribution
* Debt, External Borrowing and Capital Movements
* Valuations of Durability
* Composite Livelihood Security Index

SOCIAL CAPITAL:

* Health Care
* Educational Attainment
* Costs of Crime
* Human Freedom Index

APPENDIX C
THE NOVA SCOTIA GENUINE PROGRESS INDEX:
HISTORY, METHODS, LIMITATIONS AND WORK IN PROGRESS

This Appendix is a continuation of the Foreword, in which the limitations of conventional measures of progress based on economic growth statistics were outlined, and where the need for better measures was described.

HISTORY: THE DEVELOPMENT OF EXPANDED ACCOUNTS

Considerable progress has been made in the last 20 years by the World Bank, OECD, United Nations, World Resources Institute and other international organizations, by national statistical agencies, including Statistics Canada and by leading research institutes and distinguished economists, in developing expanded economic accounts which include critical social and environmental variables. The new internationally accepted guidelines in *The System of National Accounts 1993* suggest that natural resources be incorporated into national balance sheet accounts and that governments develop a "satellite system for integrated environmental and economic accounting," and a satellite account to measure the value of unpaid household work.

Accordingly, Statistics Canada, in December, 1997, released its new *Canadian System of Environmental and Resource Accounts (CSERA),* which consist of natural resource accounts linked to the national balance sheets, material and energy flow accounts linked to the input-output tables and environmental protection expenditure accounts. Statistics Canada has sponsored an international conference on the measurement of unpaid work, has produced its own extensive valuations of household work and is developing a *Total Work Accounts System (TWAS)* which includes both paid and unpaid work (Statistics Canada 1997; Stone and Chicha 1996). Every six years an extensive time use survey is now part of Statistics Canada's General Social Survey. Other agencies are also moving in this direction. Human Resources Development Canada, for example, has recently issued an Index of Social Health for all the provinces and for the country as a whole.

Some composite indices, like the Measure of Economic Welfare (MEW), the Index of Sustainable Economic Welfare (ISEW), the Genuine Progress Indicator (GPI) and the Index of Economic Well-being (IEW), incorporate up to 26 social and environmental indicators, including unpaid work, income distribution, changes in free time and valuations of natural capital and the durability of consumer goods (Messinger 1997, Cobb et. al. 1995a, Osberg and Sharpe 1998, GPI Atlantic 1998)[109]. These indices also distinguish direct contributions to economic welfare from defensive and intermediate expenditures and from economic activities that produce an

[109] Messinger compares the MEW and the original GPI and replicates the models for Canada. On the original GPI (Genuine Progress Indicator), see Cobb *e*t al.. 1995a. See also GPI Atlantic, *Measuring Sustainable Development: Application of the Genuine Progress Index to Nova Scotia,* January, 1998 and *Project Profile,* March, 2000. This and other GPI materials are available at www.gpiatlantic.org.

actual decline in well-being. There have been continuing improvements in methodologies and data sources in recent years and excellent models are now available for application.

In fact, the current interest in social indicators and comprehensive measures of progress owes a strong debt to the pioneers in this field of the late 1960s and early 1970s, who recognized the limitations of the GDP and sought to go beyond them. Nordhaus and Tobin's Measure of Economic Welfare and similar efforts to expand the definition of national wealth led to the development of new measurement instruments which today form the basis of recent efforts in this field.

At that time, in the early 1970s, the pioneers' understanding of the potential importance of time use surveys and environmental quality indicators was not matched by the availability of data in these fields. The early recognition of the importance of valuing natural resources, for example, initiated the process of gathering data that did not exist at the time. The work of Andrew Harvey and others in constructing the first standard time use surveys, the development of state of the environment reporting in the same era and the emergence of other important social indicator measurement tools, have now produced and made available the actual databases that make the Genuine Progress Index possible.

For the first time, 10 and 20-year time series for social and environmental indicators can actually be created. In short, the construction of an actual policy-relevant GPI at this time should not be seen as a "new" phenomenon, but as a natural evolution of earlier work in the field. The basic principle linking and integrating the components of these expanded accounts is the view of "sustainable development", which reflects a concern (a) to live within the limits of the world's and the community's resources and (b) to ensure the long-term prosperity and well-being of future generations.

Both inter-generational and intra-generational equity are cited as specific characteristics of sustainability in the Brundtland Commission's seminal definition of sustainable development:

> *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs....But physical sustainability cannot be secured unless development policies pay attention to such considerations as changes in access to resources and in the distribution of costs and benefits. Even the narrow notion of physical sustainability implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation.* (WCED, 1987)

Statistics Canada notes that, from this definition,

> *A consensus has emerged that sustainable development refers at once to economic, social and environmental needs....A clear social objective that falls out of the definition (of sustainable development) is that of equity, both among members of the present generation and between the present and future generations....It is clear that the spirit of sustainable development implies that all people have the right to a healthy, productive environment and the economic and social benefits that come with it.* (Statistics Canada 1997).

The new accounts also use cost-benefit analysis that includes environmental and social benefits and costs and an investment-oriented balance sheet approach that includes natural and social capital assets, to provide a more comprehensive view of progress than is possible with the current-income approach of the GDP.

The current emphasis on "growth" is replaced, in the new accounting systems, by a concern with "development," as defined by former World Bank economist, Herman Daly:

> *Growth refers to the quantitative increase in the scale of the physical dimension of the economy, the rate of flow of matter and energy through the economy and the stock of human bodies and artifacts, while development refers to the qualitative improvement in the structure, design and composition of physical stocks and flows, that result from greater knowledge, both of technique and of purpose* (Daly 1994).

VALUES, APPROACH, METHODS AND DATA SOURCES IN THE NOVA SCOTIA GPI

In essence, the fundamental approach of the Nova Scotia Genuine Progress Index is to assess the economic value of our social and environmental assets and to calculate their depreciation or depletion as costs. Maintenance of these capital assets is seen as providing the basis for economic prosperity. As such, the Nova Scotia GPI is a step towards fuller cost accounting than is possible by valuations of produced capital alone.

Value-Based Measures

Any index is ultimately normative, since it measures progress towards defined social goals. All asset values can therefore be seen as measurable or quantifiable proxies for underlying non-market social values such as security, health, equity and environmental quality [110]. In the case of this particular component of the GPI, the normative value or goal that serves as the standard for measuring genuine progress is the health of our forests in all their aspects, and their capacity to continue performing a wide range of valuable functions. This includes protection of watersheds and soil quality, timber and recreation for human use, habitat for wildlife, climate regulation and carbon sequestration, and a range of other ecosystem and social functions.

Indeed, it is demonstrated that these functions are complementary and mutually supportive, and that the commonly accepted notion of "trade-offs" between timber values and other forest functions is illusory when a long-term perspective is adopted. Indeed, the capacity of forests to perform all their functions satisfactorily, including provision of invaluable ecosystem services, actually enhances the timber value of forests as well. If, for example, particular harvest methods deplete soil quality and produce erosion, then future timber productivity will be compromised.

[110] For the Nova Scotia GPI, these norms are defined in *Measuring Sustainable Development: What the Genuine Progress Index Can Do For Nova Scotia,* pages 12-15: presentation to the N.S. Government Inter-Departmental Consultation, March 3, 1998, World Trade and Convention Centre, Halifax. Available at www.gpiatlantic.org.

Similarly, the loss of age and natural species diversity can diminish supplies of valuable wide-diameter and clear (versus knotty) lumber, and it can compromise forest resilience and resistance to disease and pest infestation as noted above.

These connections are still less well understood in the forest sector than in the fisheries, where it is now fully accepted that a decline in natural resource health (collapsing fish stocks) had devastating effects on the economy and employment. A report on Maritime woodlots by the National Round Table on the Environment and the Economy included specific warnings that current unsustainable harvesting practices could lead to a resource and industry collapse analogous to that in the ground-fishery (NRTEE 1997). It is hoped that the GPI approach and this report in particular can contribute to greater understanding of the potential linkages between ecosystem and economic values in Nova Scotia forests so that the hard lessons learned from the fisheries crisis do not have to be repeated in another resource sector.

In short, the value of "*forest* ecosystem health and integrity," as a defined goal in the Genuine Progress Index, is not at the expense of the "*timber* values" that are currently measured in the GDP. Rather, it is a broader and more comprehensive value that *includes* the value provided by forests in producing timber for human use and associated employment opportunities, and that demonstrates the linkages between protection of forest ecosystem functions, enhancement of timber values and job creation. Protection of the full range of forest functions is therefore the primary indicator of success in moving towards the goal of "forest health and integrity," and in strengthening a vital ecological and social asset that is essential to human life on earth. Conversely, a decline in the capacity of Nova Scotia's forests to perform their full range of ecological, social and economic functions successfully signifies a depreciation of that natural and social capital and an erosion of its value.

Despite the inclusiveness of the GPI approach, there is no question that it does represent a fundamental challenge to current assumptions and practices. When the GDP and economic growth statistics are used to assess well-being and prosperity, more production, more spending, and more consumption are signs of progress. In short, "more" is always "better." In the GPI, by contrast, "less" is frequently "better." *Less* crime, pollution, sickness, accidents, natural resource depletion and fossil fuel combustion (the primary source of greenhouse gas emissions) are indicators of genuine progress from the GPI perspective, in marked contrast to the GDP, which counts increases in all these areas as contributions to prosperity.

Although the materialist illusion that "more" is always "better" is still pervasive, the GPI approach is actually common-sense economics that reflects universally shared social values. The GPI quite simply counts crime, pollution, sickness, natural resource depletion and greenhouse gas emissions as *costs* rather than gains to the economy, with reductions signifying "savings" to society and improvements in long-term well-being.

It must be emphasized here that there is no escape from the normative basis of any measure of progress. When the GDP is used to assess well-being, it is not objective (as is generally assumed), but embodies the value that "*more*" production and "*more*" spending are always *"better."* The GPI accounting system also has an explicit value base. In this case, the normative values are that less crime, less pollution, a stable climate, and healthy and diverse forests are "better" for human well-being than more crime, more pollution, climate instability, and degraded forests.

GPI Atlantic feels confident, as a result of 18 initial months of extensive consultations (1996-1998), that its core GPI indicators represent consensus values among Canadians beyond any partisan or ideological viewpoint and are not counter-intuitive to basic common sense. No matter how controversial a report like the present one may be, it is still based on a shared value that healthy forests are a desirable goal. How a healthy forest is defined may be the subject of debate, but all agree that a healthy forest is more desirable than a degraded one. It is the unexamined assumption that the GDP and economic growth measures are "neutral" and "objective" measures of well-being, that allows their misuse for a purpose that the architects of national income accounting never intended. Once examined closely, that false assumption quickly falls apart and the GPI values are seen as representing the common goals and shared objectives of Canadians.

One important caveat must be added here for the natural resource and environmental components of the GPI. Unlike some of the GPI social and economic components like crime and employment where impacts are more immediately felt, the impacts and costs of natural resource degradation can be subtle and long-term. Cycles of forest succession, for example, span two or more generations, and it can take hundreds of years to restore a degraded forest to its natural state. This lack of immediacy frequently blunts policy initiatives designed to support more sustainable harvesting practices. The inclusion of natural resource accounts in the Genuine Progress Index therefore requires that we transcend a narrow short-term perspective and comprehend our "well-being" in terms of impacts on our children, on future generations and on other species.

The challenge to conventional thinking is particularly acute because our own prosperity may temporarily increase by expanding the area of forest clearcut and accelerating the pace of forest degradation, just as our standard of living appeared to rise in the 1980s through an expansion of government spending and debt. Again, it takes some raising of awareness to understand that the costs and impacts of excessive current consumption will be borne by our children and by future generations, whether through debt-induced service reductions, climate change damage cost, or depleted natural resources.

The connection between natural resource health and well-being therefore clearly requires a longer-term perspective than some other components of the GPI. Because the immediacy of our narrower conventional desires frequently inhibits that perspective and undermines effective policy initiatives, a key purpose of this report is simply to raise awareness among ordinary Nova Scotians.

If this province is to take a lead in acting responsibly to protect the value of our precious forest resources, our environment and the interests of future generations, a concerted educational campaign will be necessary for Nova Scotians to support actions which can become a model for the country and the world. This report is intended primarily as a contribution to that educational effort.

Data Sources and Methodology

The Nova Scotia GPI uses existing data sources in its valuations and applies the most practical and policy-relevant methodologies already developed by the World Resources Institute, the OECD, the World Bank, national statistical agencies and other established research bodies. In particular, the Nova Scotia GPI relies on published data from Statistics Canada, Environment Canada, the NS Department of Natural Resources (DNR), Department of Fisheries and Oceans (DFO) and other government sources where ever possible, to ensure accessibility and ease of replication by other jurisdictions.

In this report, DNR forest inventories and the Canadian Forest Service's National Forestry Database are the principal data sources, with supplementary information gathered from DFO Recreational Fishing Surveys, the Nova Scotia Department of Finance, Statistics Canada, the province's Wildlife Advisory Council, and several other sources.

Precautionary Principle

Inevitably, the assessment of economic values for forest ecosystem services is an imprecise science, and predicted long-term changes due to current harvesting procedures are uncertain. When future impacts are uncertain but *potentially* damaging and even irreversible, the Genuine Progress Index follows the "precautionary principle." This widely accepted dictum, enshrined in the Nova Scotia Environment Act and in Canada's international commitments, holds that scientific uncertainty must not be a cause for inaction when there is the potential for serious environmental damage.

Though further research is needed in many areas to improve these forest accounts, GPI Atlantic is convinced that the methods and data sources underlying the evidence presented here are sufficiently sound to warrant significant changes in the province's forest practices at this time. If more conclusive evidence to the contrary, based on improved methodologies and data sources, becomes available over time, then policy can shift accordingly.

The fundamental approach used in all GPI natural resource accounts is to value resources as natural capital assets that perform a wide range of interconnected ecological, social and economic functions and provide both direct and indirect services to human society and the economy. These assets are also subject to depreciation, just as manufactured capital is, with two important caveats. First, unlike manufactured capital, the services provided by renewable natural capital can be sustained over time, and there is therefore no *inherent* reason for forests, soils, fisheries and water resources to depreciate if they are used responsibly. Secondly, again unlike manufactured capital, lost ecosystem services are frequently irreplaceable, as for example when species become extinct. Nevertheless, it is completely appropriate to consider resource depletion and degradation as a depreciation of value from an economic point of view.

A Pilot Project

In its methodologies and approach, the Nova Scotia GPI is designed as a pilot project for Canada and to that end has received invaluable assistance from Statistics Canada in data access, consultation on methodologies and analysis, advice and review of draft reports, and staff support. Start-up funding for the Nova Scotia GPI was provided by the Nova Scotia Department of Economic Development and ACOA, through the Canada – Nova Scotia Cooperation Agreement on Economic Diversification. For more information on the background, purposes, indicators, policy applications and methodologies of the Nova Scotia GPI as a whole, please see the background documents on the GPI Atlantic web site at http://www.gpiatlantic.org.

A primary goal of the Nova Scotia GPI is to provide a data bank that can contribute to the Nova Scotia government's existing outcome measures. The reports and data will therefore be presented to Nova Scotia policy makers stressing the areas of policy relevance. Conclusions will emphasize the most important data requirements needed to update and maintain the index over time. The GPI full-cost accounting methods, that include social and environmental values, can also be used to evaluate the impacts of alternative policy scenarios and particular investment strategies on overall progress towards sustainable development in the province. These methods have been employed in the second volume of these forest accounts, which examine the potential for sustainable harvesting methods currently in use in Nova Scotia and beyond to provide the basis for a new forest strategy for the province.

What the GPI is Not

Just as the GDP has been misused as a measure of progress, there are also several potential misinterpretations of the GPI and misuses of the data it presents. These will be discussed in detail within each of the separate modules as they are presented. But it may be helpful to list some of the major issues at the start.

First, the GPI is not intended to replace the GDP. The GDP will undoubtedly continue to function for the purpose for which it was intended, as a gross aggregate of final market production. It is not, therefore, that the GDP itself is flawed. It is the *use* of the GDP as a comprehensive measure of overall progress that is being challenged and it is this need that the GPI attempts to address.

Identifying omissions from our measures of progress does not imply that the GDP itself should be changed to include these assets. The purpose of the GPI reports, therefore, is not to suggest that unpaid work and non-market forest values should be included in the GDP, or that the costs of crime, water pollution and climate change damage be subtracted from the GDP. Nor do the GPI natural resource accounts and environmental quality valuations recommend the creation of a "green GDP", or "net domestic product" which subtracts defensive expenditures on environmental protection. This can be done, but it is not the purpose of the GPI.

Rather than suggesting changes to the GDP, the GPI in effect adopts a qualitatively different approach. While the GDP is a current income statement, the GPI presents a balance sheet of social, economic and environmental assets and liabilities and reports the long-term flows or trends that cause our assets to appreciate or decline in value. It is only our current obsession with short-term GDP growth trends that is misplaced. The GPI seeks to "put the GDP in its place" rather than to abolish or change it. If the GDP is simply used for the purposes its architects intended, then there is no problem with the GDP per se.

The authors of the original U.S. GPI suggested that misuse of the GDP is analogous to evaluating a policeman's performance by adding up the total quantity of street activity he observes, with no distinction between dog walkers, car thefts, children playing, and assaults (Cobb et. al. 1995a). Just as we expect more of our policeman -- the capacity to distinguish benefit from harm, for example, so we need a performance measurement capable of distinguishing the benefits and costs of economic activity. To extend the metaphor, the GDP is still necessary, just as the quantity of street activity is still important in order to decide where to deploy the policeman most effectively. But once deployed, effective policing and effective policy can only be judged by qualitative criteria.

Second, the GPI assesses the economic value of social and environmental assets by imputing market values to the services provided by our stock of human, social and environmental capital. But this imputation of market values is not an end in itself. It is a temporary measure, necessary only as long as financial structures, such as prices, taxes and monetary incentives, continue to provide the primary cues for the actual behaviour of businesses, consumers and governments.

Monetization is only a tool to communicate with the world of conventional economics, not a view that reduces profound human, social and environmental values to monetary terms. It is a necessary step, given the dominance of the materialist ethic, in order to overcome the tendency to undervalue the services of unpaid labour, natural resources and other "free" assets; to make their contribution to prosperity clearly visible; and to bring these social and environmental assets more fully into the policy arena.

Monetization also serves to demonstrate the linkages and connections between non-market and market factors, such as the reality that depletion of a natural resource will eventually produce an actual loss of value in the market economy. But monetary values should never be taken as a literal description of reality.

In order to separate ends from means, the first two GPI reports on the value of unpaid work presented time use valuations first as the basis of the secondary and dependent, monetary valuations. In the third GPI report, on costs of crime, crime rates were presented first as the basis of the secondary, dependent monetary valuation of the costs of crime. Similarly, in the natural resource and environmental accounts being released this year and next, physical accounts will always precede and form the basis for the subsequent monetary accounts.

In the present report, likewise, physical and qualitative indicators are presented before economic costs and valuations. For example, the carbon sequestration value of Nova Scotia forests and their contribution to the global carbon budget are estimated first, in Chapter 10, according to a physical criterion -- the total tree carbon in tonnes stored in provincial forests according to age class and cover type (softwood or hardwood). That physical valuation is then translated into monetary terms as a second step, in order to estimate the potential climate change damage costs avoided. Such secondary derived values are always dependent on primary physical valuations and have no inherent reality in their own right. They should always be understood as simple strategies to bring neglected physical realities onto the policy agenda.

As the grip of market statistics on the policy arena is gradually loosened, the desired direction for the GPI is to return to the direct use of time, environmental quality and social indicators in decision making. This will also allow for greater accuracy and precision than relying on derivative economic values.

While the assignment of monetary values to non-market assets may appear absurd and even objectionable, we do accept court awards for grief and suffering and insurance company premiums on life and limbs as necessary measures to compensate actual human losses. We pay higher rents for dwellings with aesthetically pleasing views and we sell our time, labour and intelligence often to the highest bidder. Similarly, in a world where “everything has its price”, monetizing social and environmental variables assigns them greater value and provides a more accurate measure of progress than excluding them from our central wealth accounts.

Ultimately, however, it must be acknowledged that money is a poor tool for assessing the non-timber values of a forest, the costs of pollution or global warming, the value of caring work, the quality of education, or the fear, pain and suffering of a crime victim. A materialist criterion cannot adequately assign value to the non-material values that give life meaning.

Eventually, therefore, the Genuine Progress Index itself should give way to multi-dimensional policy analysis across a number of databases. New Zealand economist Marilyn Waring suggests a central triad of indicators – time use studies, qualitative environmental assessments and market statistics – as a comprehensive basis for assessing well-being and progress (Waring 1998).

In the meantime and only so long as market statistics dominate our economic thinking and our policy and planning processes, the GPI can provide a useful tool for communication between the market and non-market sectors. By pointing to important linkages between the sectors, the GPI itself can provide a means to move beyond monetary assessments towards a more inclusive and integrated policy and planning framework.

Third, the Genuine Progress Index is not designed to be a final product, but it is a significant step in the direction of more comprehensive measures of progress than are currently in use. The GPI itself should be seen as a work in progress subject to continuous revision, improvement in methodologies and inclusion of additional variables. It will continue to evolve in form and content with further research, the development of new methods of measurement and the availability of improved data sources. Given these caveats, all interpretations and viewpoints expressed in this and other reports are designed to raise important issues for debate and discussion rather than as definitive or final conclusions or prescriptions.

For example, the GPI researchers have wrestled long and hard with definitions of "defensive expenditures" and the degree to which these might be interpreted in measures of progress negatively as surrogate values for damage incurred or as positive investments in environmental restoration. In other words, are *more* defensive expenditures a sign of progress or not? Or do the indicators of genuine progress themselves need to be based squarely on the physical indicators themselves and separated entirely from the secondary economic valuations?

High expenditures on restorative forestry are, for example, *both* a cost of prior excess and neglect *and* a positive sign that concerted efforts are being made to take necessary action. For this reason the actual quantity of defensive expenditures is not easily interpreted as a measure of progress and it is preferable to base such assessments and annual benchmarks on the core physical indicators which are the basis for subsequent economic cost-benefit analyses.

Similarly, much more work needs to be done on separating resource stock accounts from flow data like harvesting rates, and on distinguishing *relative* progress towards greater sustainability, which refers to changes in human activity, from a more absolute standard of sustainability based on nature's own balance and capacity to support human activity. For example, attainment of the internationally agreed Kyoto targets, a sure sign of *relative* progress, will not prevent the further atmospheric accumulation of greenhouse gases or the acceleration of global warming trends. The more absolute standards require difficult assessments of sustainability thresholds and ecosystem "carrying capacity."

The confusion and lack of conceptual clarity on these important issues has been particularly acute in the forest sector. Silvicultural investments may well signal a *relatively* more sustainable approach to forest management than clearcutting with no replanting. But a more absolute standard of sustainability takes into account changes in natural age and species diversity and other qualitative criteria that are not considered in routine industry descriptions of "sustainable" forest practices. At the same time, it must be acknowledged that assessments of the most natural, valuable and sustainable mix of age and species types, and of the management practices that most closely resemble natural forest succession cycles, are difficult. In this case, the structure of the original Acadian forest might serve as the benchmark for that more absolute standard of sustainability.

Rather than offering any pretence of definitive answers to these challenging questions, GPI Atlantic hopes that its natural resource and environmental quality accounts stimulate further productive debate among researchers that will provide ever greater clarity and accuracy in future updates of the GPI work. In sum, GPI Atlantic is not wedded to any particular method of measurement or to any final assessment of results, but seeks to improve both its accounting methodologies and the accuracy of its results over time in accord with the constructive feedback its work receives.

Fourth and finally, it must be stated that the economic valuations are not precise. Any attempt to move beyond simple quantitative market statistics to the valuation of goods and services that are not exchanged for money in the market economy will produce considerable uncertainty. In the GPI report on the economic value of unpaid household work, for example, six different valuation methods were compared, each producing different aggregates. In the GPI *Cost of Crime* report, a range of cost estimates was presented from the most conservative measurements to more comprehensive estimates that included costs of unreported crimes; retail “shrinkage”; losses of unpaid production; and suffering of crime victims. The GPI *Greenhouse Gas Accounts* and the cost-benefit case study in the GPI *Water Quality Accounts* similarly presented a range of values based both on different discount rates and on high and low-end estimates of projected changes in climate, tourism, property values and a wide range of other variables.

This problem of precision is particularly acute in the natural resource accounts, with attempts to place an economic value on ecological services and the non-market functions of natural assets. For example, there is no doubt that water bodies, wetlands and forest watersheds provide vitally important functions to human society, including waste and nutrient cycling; erosion, flood and storm control; recreation; water filtration and purification; and food production and that these functions have vital economic value. But these functions have so long been accepted as "free," that any diminution of functional capacity has gone unrecorded in standard accounting procedures that track only market transactions in which money is exchanged.

How then, are such functions to be valued? Clearly a reduced natural nutrient or waste cycling capacity in a water body as a result of nutrient or waste overload, will have to be replaced by waste treatment upgrades that compensate for the loss of "free" ecological services, if water quality is to be maintained. In its recently released Water Quality report, GPI Atlantic used the capital costs of engineering upgrades as a surrogate value for the cost of lost nutrient cycling capacity. But should the operating costs of the replacement facility also be included? These difficulties are vastly accentuated in the present account, for example, in estimating the potential climate change damage costs from a loss of forest carbon sequestration capacity, because of the great difficulty in estimating the local impacts of global trends and global impacts of local forest practices.

In these forest accounts, there are many such difficult valuation choices and the GPI valuations are based on the authors' best understanding of the available scientific and economic assessments. These few examples suffice to demonstrate that any economic assessment of natural resource values, or costs of natural capital depreciation, cannot pretend to be precise.

WHAT THE GPI CAN CONTRIBUTE

Despite all these major qualifications, it is finally important not to throw the baby out with the bath water! The GPI is in its earliest stages of development, but it is still considerably *more* accurate to assign explicit economic value to unpaid production, natural capital and other social and environmental assets than to assign them an arbitrary value of zero, as is currently the case in our conventional economic accounting system. And it is far *more* precise to recognize natural resource depletion and crime, sickness and pollution costs as economic liabilities rather than to count them as contributions to a more "robust" economy and to social progress, as is presently done.

Though the potential impacts of forest harvesting and management practices are extraordinarily difficult to estimate, and though the web of cause-effect relationships is infinitely complex, it would be utterly foolhardy to deny the reality of these relationships or to pretend that costs will not be incurred. While it is very important to improve on the precision and methodologies of natural resource accounting and of social and environmental valuations, the current lack of precision should not be taken as an excuse for any delay in incorporating these mechanisms into our accounting systems. Efforts to value social and environmental assets, using the best available methodologies and data sources, still provide far greater accuracy and precision than continued reliance on an accounting system and measure of progress that gives *no* value to these assets and counts their depletion as gain.

In the long run, the GPI is intended as one step towards greater "full cost accounting" both in our core national and provincial accounts and as the basis for taxation and financial policy that will ultimately enable market prices themselves to reflect the full values and costs of embodied resources. The transition from externalized to internalized costs, from non-market to market valuations and from fixed to variable pricing mechanisms are the three core principles of full cost accounting.

For example, the inclusion of climate change costs in gasoline, energy and road pricing can be far more effective in encouraging resource conservation than taxation systems based entirely on income. Similarly, market pricing of old-growth lumber that reflects the wide range of valuable services provided by ancient forests would encourage appropriate management and practices, and promote their conservation. The appropriate pricing of all wood products will discourage wasteful practices and promote increased recycling. Incorporation of natural resource valuations into our core economic accounts is, therefore, the first essential step in improving the efficiency of market mechanisms so that they reflect the full range of social, economic and environmental benefits and costs of both production and consumption processes.

The Nova Scotia Genuine Progress Index is not an isolated effort, but part of a global movement to overcome the recognized flaws in our current measures of progress and to ensure a more sustainable future for our children and for the planet. Indeed, as we have seen, the new System of National Accounts, Canada's own international commitments, and the considerable advances in developing expanded measures of progress, in recent years, require that further efforts be made to integrate social, economic and environmental variables in our accounting mechanisms. The costs of continuing to ignore our social and environmental assets are too great. We have learned the hard way that measuring our progress in strictly materialist terms and without reference to our natural environment, which is the source of all life and of human survival, ultimately undermines well-being and prosperity.

In sum and with all its limitations, the GPI is a substantial step towards measuring sustainable development more precisely than prevailing accounts are able to do. It is itself a work in progress designed to help lay the foundations for the new economy of the 21st century, an economy that will genuinely reflect the social, spiritual, environmental and human values of our society.

NOVA SCOTIA GPI: RELEASE OF NATURAL RESOURCE ACCOUNTS, 2001-2002

This particular report is one of several Nova Scotia GPI natural resource and environmental accounts to be released in 2001-2002, on which research has been ongoing for the past four years. The first of these resource accounts, the *GPI Water Quality Accounts,* was released in July, 2000. In March 2001, GPI Atlantic will released its ecological footprint analysis and in

August, 2001, released its greenhouse gas accounts. Resource accounts for fisheries were released in September, 2001. The first component of the GPI soils and agriculture accounts were released in April 2001, and the next component is scheduled for release in January, 2002. The GPI air quality component is expected to be released in February, 2002; and the first stage of a sustainable transportation analysis that applies full-cost accounting principles to a comparison of different modes of transportation is scheduled for release in March, 2002. GPI Atlantic will also release its solid waste component in April, 2002.

This release of data on the health of Nova Scotia's natural resources and on the province's environmental quality, follows the release of several social accounts. These included full reports on the economic value of civic and voluntary work and on the economic value of unpaid housework and child care, released in July and November, 1998, with voluntary work updates released in February, 1999 and February, 2000. Those two studies measured important economic assets that are hidden and unvalued in our current accounting system and demonstrated that unpaid voluntary work and household production provide critically important services to society that are an essential precondition for a healthy market economy. The studies also showed that any deterioration in these sectors directly affects the standard of living and quality of life and has serious repercussions for the market economy.

The third GPI data release, in April, 1999, laid the groundwork for these natural resource accounts, by challenging the conventional economic growth paradigm, in which "more" is always assumed to be "better." GPI Atlantic's *Cost of Crime* report showed clearly that growth in and of itself does not necessarily signify an improvement in well-being and that this simplistic, prevailing assumption can mislead policy makers and skew the policy agenda. The contrast between the *Cost of Crime* report and the first two reports on the value of unpaid work, is therefore a useful illustration of Simon Kuznets' dictum that "goals for 'more' growth should specify of what and for what".

While higher crime rates produce more spending on prisons, police, burglar alarms and theft insurance, all of which make the GDP grow, crime clearly diminishes the quality of life and diverts precious economic resources from health, education and other activities that enhance human and social welfare. In the GPI, as discussed earlier, "less" is frequently "better." Unlike the signals emanating form the GDP, in which growth of any kind signifies "progress" and a "stronger" and more "robust" economy, it was pointed above that the GPI counts *less* pollution, crime, sickness, fossil fuel combustion and natural resource depletion as signs of genuine progress. *The Cost of Crime* was the first GPI report to demonstrate that principle which applies equally to natural resource depletion.

In the last eighteen months, GPI Atlantic has also released the first four indicator sets of its population health component, an assessment of *Women's Health in Atlantic Canada,* and reports on the costs of obesity, tobacco, and AIDS. It was demonstrated, for example, that obesity costs the Nova Scotia health care system $120 million a year in direct costs and a further $140 million annually in lost productivity, while tobacco costs the economy more than $400 million a year. Though sickness produces more spending on doctors, hospitals and drugs, all of which make the GDP grow, the GPI recognizes *less* sickness and improved population health as a core indicator of genuine progress.

In July, 2001, GPI Atlantic released one of its core economic components on Income Distribution in Nova Scotia. Other economic components of the GPI, particularly on employment and work hours are scheduled for release in the summer of 2002.

Investment in Renewable Resources

The previous GPI data releases to date help establish a context for this present report on Nova Scotia forests and for the other natural resource accounts. Just as crime signifies the deterioration of a social capital asset (a peaceful and secure society), so a decline in forest values signifies the deterioration or depreciation of an environmental asset. As noted above, the Genuine Progress Index treats natural, social and human capital in the way that the conventional accounts treat produced capital, assessing both the value of the services provided and depreciation over time.

If the province's forests are harvested unsustainably and if this capital asset deteriorates in value, then the continued provision of vital ecological, social, and economic services is threatened. In such a circumstance, restorative forest practices are required as a renewed investment in natural resource conservation, in the same way that a factory owner must consider the repair or replacement of old or malfunctioning machinery. The major caveat to this analogy, as noted above, is that, unlike manufactured capital, which always depreciates over time, there is no *inherent* reason for natural capital to depreciate in value, because it has the capacity for self-renewal. If used sustainably, the quality and value of natural capital can actually be maintained *without* additional investment.

That is a big "if," but the distinction must be borne in mind to overcome the dangerous prevalent assumption that accepts the decline in environmental quality as "inevitable," or assumes the infinite substitutability of manufactured capital for natural capital. Natural capital assets can, in effect, provide a range of ecological services indefinitely and even repair and replenish themselves, if they are borrowed from on an ecologically sustainable basis.

The notion of a "stable" climate or a "resilient" forest, for example, does not imply that climate never changes or that no timber harvesting occurs. Rather there is a natural range of forest succession and historical climate fluctuation and change that may now have been dramatically distorted as a result of human activity. On a global scale, the capacity of forests to provide timber and other vital resources to human societies for thousands of years and the balance between forest succession, human activity and renewal have only recently been threatened by massive deforestation in the present century.

The need for re-investment in natural capital therefore literally signifies the *cost* of previous unsustainable use and of human activities that have previously failed to respect and understand the natural limits, cycles and balance that exist in the natural world. Unlike manufactured capital depreciation, which represents a drawing down on *past* and *present* resources, natural capital depreciation *also* represents a drawing down on *future* resources. Depleting these resources in the interests of present consumption therefore directly threatens the welfare of future generations.

For example, the marine environment and freshwater rivers and lakes are *inherently* capable of providing as stable a level of fish stocks for future generations as at any time in the past. The 80% decline in Atlantic salmon returns, described in the GPI Water Quality report, is therefore not only a present cost of unsustainable resource use and human pollution, but also a cost that will be borne by our children and for many generations to come. The "re-investment" that future generations will have to make in forest and water restoration and in other forms of natural resource conservation, to ensure their own survival, is therefore a cost that they will bear as the price of actions by past and present generations. Because it literally takes hundreds of years to restore a clear-cut forest to its natural state, this displacement of cost burdens to future generations requires a very long-term perspective.

While the depreciation metaphor is useful to illustrate the concept of natural capital, this crucial distinction between manufactured and natural capital must always be kept in mind. Since produced capital depreciation is inevitable, further investment in manufactured capital can potentially *add* real value that enhances well-being and improves the standard of living and quality of life of future generations. By contrast, natural capital depreciation that requires further investment *always* signifies a prior *cost* incurred through previous excess or unsustainable use. Unsustainable human activity in effect defers investment costs to future generations, because sustainable use would allow the resource to regenerate naturally without further investment.

THE NOVA SCOTIA GPI: NEXT STEPS

This brief overview establishes the context of this present report in the framework of past and ongoing work on the Genuine Progress Index. Altogether the Nova Scotia GPI will eventually consist of 22 components, listed in Appendix B.[111] By the fall of 2002, enough components of the GPI will be complete for any jurisdiction to adopt the index as an actual policy tool and strategy for sustainable development even without completion of all potential components.

GPI Atlantic will also continue to cooperate and work closely with other parallel efforts in Canada and throughout the world, including the new sustainable development indicators initiative of the National Round Table on the Environment and the Economy, the ongoing development of resource satellite accounts, total work accounts and the Index of Social Health at Statistics Canada, the Index of Economic Wellbeing developed by the Centre for Living Standards, the exploration of new health indicators by Health Canada, the ongoing pioneering work of Redefining Progress in the USA, an Alberta GPI project that began in the fall of 2000, the outstanding community indicators work in Newfoundland, the Quality of Life Indicators Project of the Canadian Policy Research Networks, and many other similar initiatives that share the goals and aspirations of GPI Atlantic. In fact, GPI Atlantic is represented on the Sustainable Development Indicators steering committee of the National Round Table, a process that will undoubtedly bring together and promote cooperation among the many synchronous indicator efforts currently under way.

As work develops, GPI Atlantic would welcome a formal national consultation to discuss the GPI results and their implications as well as the results of similar indicator projects, to review the methodologies and measurement tools in detail, to identify core indicators that can serve as annual benchmarks of progress, to make specific recommendations to fill data gaps necessary to

[111] The components of the Nova Scotia GPI are described in detail in the GPI Atlantic profile entitled *Measuring Sustainable Development,* (updated March, 2000). Available at www.gpiatlantic.org.

maintain the index over time, and to explore the potential for aggregating particular indicator sets.

In consultation with Statistics Canada and in the interests of policy relevance, it has been decided to adopt a sectoral "bottom up" approach to the Nova Scotia GPI, presenting as comprehensive a portrait as possible of each of the 22 components that comprise the Index. Wherever possible, as mentioned earlier, monetary values will continue to be imputed in order to demonstrate linkages between the market and non-market sectors of the economy, and to facilitate policy adoption and communication with more conventional economic approaches.

When this sectoral development is complete, aggregation will present a major challenge and it is now anticipated that the final GPI will more likely consist of several sets of sub-indices, corresponding to the five-fold division of components listed below, rather than as a single aggregated "bottom line" index. Challenges will include the elimination of double-counting, the consideration of appropriate weighting mechanisms, and the identification of core indicators that will allow a more integrated Genuine Progress Index to assess progress towards overall sustainable development in the province. The construction of this more composite index will require intensive consultations with Statistics Canada staff, other government officials and independent experts, and is not a task GPI Atlantic plans to undertake alone.

While the initial construction of the index is complex and time-consuming, as these first reports demonstrate, the goal is that the final index be easy to maintain and update in future years, that the design enable ready comparability with other jurisdictions, and that results are presented with a view to practical policy relevance and application. Each report describes in detail the methodologies used to derive results, so that other provinces can more easily replicate the measurements. Each report also describes the data requirements necessary to maintain the index and points to existing data gaps, and each report also emphasizes major policy implications indicated by the findings. Upon completion, the Nova Scotia GPI should not be regarded as a final and rigid formula, but as a work in progress that will be constantly modified and refined to reflect improved methodologies and new approaches and data sources.

Finally, it should be mentioned that, alongside these national, provincial and regional efforts to establish macro-indicators of well-being and sustainable development, GPI Atlantic is also working with two Nova Scotia communities, in rural Kings County and Glace Bay in industrial Cape Breton, to develop genuine progress indicators at the local level. These community indicators can serve as highly useful tools for sustainable community development strategies by identifying local strengths and weaknesses and by suggesting practical policy initiatives to local planners, community groups and public officials to improve the well-being and quality of life within communities. These two projects are also pilots that will provide practical tools for measuring genuine progress to communities throughout Canada.

That is the basic framework for this release of data for the Nova Scotia GPI forest accounts and for the GPI natural resource accounts as a whole. The more detailed background documents for the project, the completed modules of the index to date, including summaries and press releases, GPI newsletters, and a summary of this report are available on the GPI web site at www.gpiatlantic.org. Information on upcoming reports and data releases will be posted on that web site and in the GPI newsletter as it becomes available.