ACCOUNTING FOR NATURAL RESOURCES IN THE FOOTHILLS MODEL FOREST

M.N. Patriquin, M.M. Spence, W.A. White

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ABSTRACT

The perceived deficiencies of the standard national accounting framework in addressing issues of sustainability have prompted the development of natural resource accounts. Many countries, including Canada, have adopted some system of natural resource and environmental accounting to augment their national accounts. Natural resource accounting is a relatively inexpensive and innovative method of assessing benefits flowing from a landscape and should be considered by government and industry for inclusion in various planning initiatives such as Detailed Forest Management Plans, land and resource management plans, and integrated resource management initiatives. While natural resource accounts are becoming more common on a national scale, regional applications are limited. This study attempts to fill this gap through the development of a natural resource account for the Foothills Model Forest study region. This natural resource account represents a baseline of values that can be used to assess the progress of Weldwood of Canada Limited toward specific objectives related to resource management goals. Market and nonmarket activities are valued to provide a better indication of the net benefits that flow from the regional landscape compared to the traditional approach, which considers only market values. The net income derived from the Foothills Model Forest landscape in 1996 was estimated at $615.4 million. Commercial activities accounted for $508.6 million (82.7%) and nonmarket components for the remaining $106.8 million (17.3%).

RÉSUMÉ

L'analyse des déficiences du système national de comptabilisation pour ce qui est de la résolution des enjeux concernant la durabilité a motivé l'élaboration de comptes de ressources naturelles. De nombreux pays, y compris le Canada, ont mis en œuvre un certain nombre de systèmes de comptabilisation de leurs ressources naturelles et de l'environnement pour affiner leur système de comptabilisation national. La comptabilisation des ressources naturelles est une méthode nouvelle et relativement économique qui permet d'évaluer les bénéfices extraits d'un paysage et dont l'adoption devrait être envisagée par les gouvernements et l'industrie dans diverses initiatives de planification telles que les plans détaillés de gestion forestière, les plans de gestion des terres et des ressources et les initiatives de gestion intégrée des ressources. Bien que les comptes de ressources naturelles deviennent de plus en plus communs à l'échelle nationale, les applications régionales restent limitées. Cette étude vise à remédier partiellement à cette situation grâce à l'élaboration d'un compte de ressources naturelles pour la région d'étude de la forêt modèle Foothills. Ce compte de ressources naturelles représente la ligne de base des valeurs qui peuvent être utilisées pour évaluer les progrès réalisés par Weldwood of Canada Limited vis à vis des objectifs fixés pour la gestion des ressources. Les activités commerciales aussi bien que non commerciales sont explicitées pour que

les bénéfices nets associés au paysage régional soient mieux évalués que dans le cadre de l'approche traditionnelle qui ne considère que les valeurs commerciales. Le revenu net découlant du paysage de la forêt modèle Foothills en 1996 a été estimé à 615,4 millions $. Les activités commerciales rapportaient 508,6 millions $ (82,7 %) tandis que les composantes non commerciales rapportaient les 106,8 millions $ restants (17,3 %).

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INTRODUCTION

The natural features of the Foothills Model Forest (FMF) offer significant environmental and economic benefits to the region and to the province of Alberta. For example, the forested landscape provides benefits through commercially viable timber operations, amenity services such as recreation, and various ecosystem services. Subsoil mineral deposits and other resources also generate significant wealth. Quantifying these benefits is of interest, especially given the current emphasis on sustainable development.

Economic activity is typically measured in terms of the gross domestic product (GDP), the amount of money exchanged for final goods and services in an economic market in 1 year. The principle of sustainable development (present generation development that does not diminish future generation development) requires that a non-declining GDP (or, more specifically, net domestic income) be maintained over time (net domestic income is defined as the total income, including profit, paid for the services of factors of production [land, labor, capital] used to produce goods and services in a region on an annual basis; it is a "net" measure because firms deduct the depreciation of their capital stock in calculating profits [Parkin and Bade 1995]). However, several deficiencies have been identified with respect to conventional measures of economic activity such as GDP. As indicators of well-being, the conventional measures sometimes behave perversely and give an incomplete picture of the full scope of economic activity. For example, extracting timber without regenerating sites reduces the value of natural capital. This concept is parallel to that of more rapid depreciation of machines and buildings if they are not maintained. As a result, GDP may not adequately address the objectives of sustainability and may send incorrect signals to policy and decision makers. Natural resource accounting has been proposed as a tool for assessing the socioeconomic sustainability of natural resource use (Repetto 1991, 1993; Nordhaus and Kokkelenberg 1999; Haener and Adamowicz 2000).

A natural resource account (NRA) can be expressed in terms of the physical quantities and economic values associated with the stock (existing level) and flow (amount extracted or added) of natural resources and environmental services on a landscape. The details of resource stocks and flows can be tracked over time to examine individual resource uses or can be aggregated to adjust conventional measures such as GDP to account for environmental linkages. As such, NRAs may provide an indication of whether natural resource use is sustainable. For example, commercial market activities may represent only a portion of the total net income derived from regional natural resources. Noncommercial and nonmarket uses of the forest such as recreation (an amenity service) and carbon sequestration (an ecosystem service), which are not currently accounted for, represent the remaining portion of income. In other words, conventional accounting may undervalue the contribution of natural resources to regional income and NRAs can be used to compensate for this shortcoming.

Natural resource accounts provide useful information for integrated resource management through the identification of both market and nonmarket values. For example, the comprehensive information contained in the NRAs could be useful for determining royalty rates and leasing policies and for balancing competing land uses. On a forested landscape, improved accounting would help in balancing timber harvesting, wilderness preservation, recreation, and other uses. In Alberta, past efforts to manage the landscape for multiple resource values have been hampered by the lack of reliable and coordinated information with respect to the stock and flows of resources on a given landscape. In addition to providing an organizational framework for data, an NRA may also assist natural resource users in the development of management plans or coordinated access plans.

The following section reviews previous studies investigating the theory and application of natural resource accounting. The third section outlines a case study NRA for the FMF, including detailed methods. The fourth section summarizes the FMF NRA and discusses implications of the analysis, gaps, and areas for future investigation.

Human Welfare and the Environment

The environment and the economy interact in a complex system. The environment acts not only as a source of raw materials and energy but also as a recipient of wastes generated by production and consumption. Therefore, the environment can be considered a form of natural capital. This concept is similar to human-made or human-produced capital, in that natural capital creates a flow of services that are used by humans (Jansson et al. 1994).

This flow of services generated from natural capital can affect human populations both indirectly and directly. Human welfare is indirectly affected when the environment is used as an input to production. Direct effects on human welfare might include changes in air quality, recreation, esthetic viewing opportunities, and food gathering (Haener 1998). The size of the initial stock of natural capital is also an important element, because changes in the existing stock might affect the future flow of services from the environment and therefore affect the welfare potential of future generations. For example, depleting the existing stock of mineral assets will affect the ability of future generations to generate similar levels of wealth (if technology is held constant).

Deficiencies in Current Accounting Frameworks

The current international standard for statistical accounting frameworks is the United Nations System of National Accounts (SNA) (United Nations 1990), which includes standardized definitions and methods of measuring national and domestic product. When the SNA was developed[1], natural resource scarcity was not the prominent issue that it is today. As a result, the SNA focuses on measuring the total demand for outputs of produced commodities to address business cycles of unemployment and inflation. According to Repetto (1991) the formation of capital plays a central role in theories of economic growth, but natural resources are not treated like other tangible assets in the SNA. Activities that deplete or degrade natural resources are not considered to represent capital consumption, and activities that increase the stock of natural capital are not considered to represent capital formation. As such, several deficiencies have been identified with respect to using the SNA to address broader goals, including natural resource scarcity.

Over the past few decades a great deal of attention has been given to identifying and ameliorating accounting deficiencies within the SNA. Although little consensus has been reached on individual issues, the work has led to the development of various "satellite" accounts in many nations (Hamilton, K. 1990. A framework for environment statistics. Stat. Can., Ottawa, ON. Working paper.; United Nations 1990; Liu 1998). In 1999, Nordhaus and Kokkelenberg edited and released a report entitled *Nature's Numbers: Expanding the National Economic Accounts to Include the Environment*; this report was produced by a committee of experts charged with the task of reviewing the current state of NRAs in relation to the SNA.

The document identified the following deficiencies in the SNA, as agreed upon by the Panel on Integrated Environmental and Economic Accounting Committee on National Statistics:

- As an indicator of economic well-being, the SNA may behave perversely with respect to environmental degradation and changing stocks of natural resources. For example, the cutting and sale of timber increases GDP, but no account is taken of the loss of timber stock, because forests are not included in the asset account. In other words, the SNA ignores the amount of natural endowment on the landscape and is therefore inadequate for examining issues of resource scarcity and sustainability. In many cases, changes in production do not reflect genuine changes in economic well-being and may even result in economic harm or potential costs to future generations.

- The SNA treats different forms of wealth inconsistently. For example, the SNA includes a full set of accounts of gross investment, net investment, depreciation, and the capital stock for produced capital, but there are no similar accounts for natural capital. With respect to produced capital, these accounts identify

[1]The SNA was developed in the first half of the 20th Century (Repetto 1991).

investments that simply replace depreciated stock and add nothing to economic well-being. Failure to track similar accounts for natural capital may yield measures of economic well-being that are not sustainable over time.

- The SNA gives an incomplete picture of the full scope of economic activity. The SNA is focused entirely on market activity and neglects economically significant inputs and outputs that are not bought or sold in the market. In terms of natural resources, these might include environmental assets such as air, water, and ecosystem services that are latent factors of production and are essentially "free."

Limiting national accounts to market sectors can produce misleading information on economic trends. As Repetto (1991, page 1) stated more than a decade ago, "The national accounts thereby create the illusion of income development, when in fact national wealth is being destroyed. Economic disaster masquerades as progress." For example, new discoveries of oil, gold, and other mineral assets are not counted among the nation's investments or as an increase in the stock of assets. Similarly, forests contribute value to the economy through timber and other forms of nonmarket forest recreation such as hunting and fishing but are not represented in conventional accounting. Significant distortions in accounting can also occur with respect to environmental quality. For example large expenditures for pollution abatement and control are captured in the accounts, but virtually none of the benefits of these measures are included. NRAs have been developed as satellite accounts to the conventional SNA in attempting to address these deficiencies.

Indicators of Sustainability

Many indicator frameworks contain a measure of economic activity. For example, the Canadian Council of Forest Ministers (CCFM 2000) uses forest sector GDP as an indicator of the contribution of the forest sector to the economy. However, given the apparent deficiencies in the current accounting framework, GDP as measured by conventional accounting may not provide an accurate picture of the wealth generated from the landscape.

There is general consensus that net domestic product (NDP), which is gross domestic product minus capital depreciation, is the most appropriate measure of welfare under conventional accounting methods (Hartwick 1990; Haener 1998). Without considering the environment, NDP can be characterized as the largest sustainable measure of wealth derived from the human-made capital stock of an economy (Hanley et al. 1997). Augmenting the accounting framework to encompass natural capital also modifies the resulting measures of economic activity, such as NDP. Including natural capital leads to what many consider a "green" measure of wealth and a more accurate depiction of a sustainable level of income (Repetto 1993).

Repetto (1993) argued that the failure to account for the degradation of domestic resources was the cause of economic difficulties experienced in Costa Rica in the early 1980s. These difficulties were originally diagnosed as a debt crisis resulting from increased foreign liabilities. The NRAs developed by Repetto (1993) demonstrated that the depreciation of domestic natural capital assets far exceeded the increase in foreign debt. Before the economic crisis, the income generated from natural resources exceeded the sustainable level, which resulted in a drawdown of resource stocks. In other words, the degradation of natural resources in Costa Rica reduced the ability to generate future income from natural resources. Indicators organized in or derived from an NRA would have sent signals that Costa Rica's forests, soils, and fisheries were not being managed at a level that would sustain economic benefits over time.

> Past failures to prevent natural resource degradation have already undermined efforts at development and poverty alleviation. This linkage is still not fully recognized by policymakers, who act as if natural resources were limitless or as if technology can always replace exhausted or degraded resources. … An economic accounting system that reflects the true condition of natural resources would provide an essential tool for use in integrated analysis (Repetto 1991, pages 3-4).

As a tool of integrated analysis, natural resource accounting has several potential applications to indicators of sustainability. First, NRAs can be used to augment conventional economic indicators, to improve their relevance to the issue of sustainability. Second, the NRA

framework is a convenient way to organize physical and economic accounts in a manner that demonstrates the linkages between the environment and the economy. Third, new index indicators of sustainability can be created from the information in NRAs.

Natural resource accounting has evolved over the past decade, and inconsistencies in methods have compromised the usefulness of augmented accounts in indicator frameworks. One of the major benefits of the United Nations SNA is the consistency it provides across nations. However, the consistency of the SNA is also a major hurdle to the creation of augmented accounts. Repetto (1991) recommended that changes in an accounting system must be introduced by an authoritative international institution such as the United Nations. While most nations follow the standard defined in the current SNA, national statistical agencies must also take responsibility for organizing databases. Consistency in methods across statistical agencies will streamline the acceptance of augmented accounts such as NRAs.

Generalized Findings of the Expert Panel

In addition to reaching consensus on the deficiencies of the conventional SNA, Nordhaus and Kokkelenberg (1999) discussed the results of the expert panel's review of the objectivity, methods, and application of integrated environmental and economic accounting in the context of broadening national accounts. A major conclusion of the panel was that augmenting economic accounts to include assets and production activities associated with natural resources and the environment is an important goal.

Such augmented accounts would provide useful data on resource trends and help governments, businesses, and individuals better plan their economic activities and investments. In addition, the rationale for augmented accounts is solidly grounded in mainstream economic analysis. NRAs provide more comprehensive measures of output, saving, and investment; ensure that the accounts treat economic activity in a consistent way for market and nonmarket activities; and provide information on the interaction between the economy and the environment so that natural and environmental resources can be more effectively managed and regulated.

NRAs also have an economic benefit in that the availability of better information would allow both the public and the private sectors to make better investment decisions. One important area where NRAs have proved beneficial is in the measurement of productivity. By providing better information about the linkages between the economy and the environment, environmental accounting in the United States has demonstrated that one of the leading causes for a decline in productivity growth is stricter health and safety regulations (Nordhaus and Kokkelenberg 1999).

One of the most persistent problems in environmental policy is the difficulty in comparing the costs and benefits of environmental regulations (Nordhaus and Kokkelenberg 1999). Improved accounting may provide the detail necessary to allow pollutant-by-pollutant or sector-by-sector estimates of the benefits and costs of regulations. In turn, this would help in refining estimates so that pollution control investments might be more effectively allocated.

NRAs also offer benefits with respect to public land management (Nordhaus and Kokkelenberg 1999). Public lands (forested or nonforested) provide a broad range of economic services. The government already receives substantial revenues from timber harvesting, mining, and leasing of rangelands. Improved accounts would assist decision makers in estimating the value of public assets (resources) and setting realistic prices for leases and licenses, in other words, estimating the actual value of the resource.

An excellent example of the pertinent role of NRAs is found within the Kyoto Protocol (Nordhaus and Kokkelenberg 1999). The potential exists that overall reductions will include both reductions in emissions from industrial sources, and reductions resulting from carbon sequestration in forests. The benefits derived from carbon sequestration could potentially offset the costs of reducing industrial emissions, and an NRA offers a method of quantifying this effect.

Accounting Frameworks

NRAs have originated from a variety of research and management objectives. Some natural resource accounting systems were adopted to augment or better define measures of wealth.

Other systems have been studied in terms of their ability to inform environmental and economic policy. Yet others only attempt to organize the vast array of physical indicators. The accounting framework adopted depends on which objective the researchers are attempting to address, yet one of the limitations in the adoption of NRAs has been the lack of a standardized method for implementation.

The biggest difference in approaches to NRAs is the relative importance assigned to economic as opposed to physical accounting. Physical accounts stress the development of detailed information of physical flows and impacts of human exposure. For example, humans are exposed to physical flows such as particle levels in air and water that might change as a result of changes in the economic system. They attempt to improve our understanding of the interaction between the economy and the environment and often include vast details on indicators. However, the nature of the different attributes and potential units of measure makes physical accounting rich in detail but poor for setting policy and determining trade-offs. Physical indicators are also subject to many of the same difficulties that plague economic measures of nonmarket and environmental activities. Whether or not a physical accounting component is used, detailed physical information remains an essential component of an economic account.

The physical approach would be emphasized when the construction of economic aggregates depends heavily on controversial analytical methods and imputations. The further the accounts from the market, the more suspect the quality of the data and the greater the cost of obtaining those data. For example, volumes and values of petroleum reserves and timber stocks can be estimated with a reasonable accuracy, but nonmarket assets are likely to be significantly more expensive and their values more difficult to estimate. Economic accounts are most useful for score-keeping and management decisions.

Development and Application of Regional-Level NRAs

The NRA framework is more common on a national scale, but its application at finer resolutions is increasing. For example, Anielski developed an initial NRA for the province of Alberta (Anielski, M. 1994. Resource accounting II: from theory to application — Alberta's timber account in 1991. Forestry and Environment Conference: Economic Perspectives II, 12–15 October 1994, Banff, AB, [presentation]). At an even finer resolution, NRAs have been proposed as a tool for assessing the socioeconomic sustainability of regional forestry practices (Haener and Adamowicz 2000).

The study by Haener and Adamowicz (2000) was the first regional-level application of natural resource accounting in Alberta. The Haener and Adamowicz (2000) NRA was constructed for a region of public forestland in northern Alberta and offered a clear picture of the market and nonmarket benefits provided by the forest. For example, commercial forestry accounted for 61.9% of net income (in 1996 income) derived from the northern region landscape, 0.3% was derived from other commercial uses, and the remaining 37.8% was derived from nonmarket components such as biodiversity maintenance, Aboriginal land use, and carbon sequestration. The results of Haener and Adamowicz (2000) provide a benchmark for the results derived for the FMF in west-central Alberta.

FMF CASE STUDY

Regional Description

The FMF is 1 of 11 model forests in Canada. It is located in west-central Alberta and covers an area of approximately 2.75 million ha. The FMF is composed of Weldwood of Canada Limited's Forest Management Agreement (FMA) area, Jasper National Park, Willmore Wilderness Park, various provincial Crown Forest Management Units, and the Environmental Training Centre's Cache Percotte Training Forest (Fig. 1). The FMF land base spans the boreal, montane, and subalpine forest regions of Canada. The FMF head office is located in the town of Hinton, a resource-based community of approximately 10 000. Hinton is located 285 km west of Edmonton and 85 km east of Jasper townsite (FMF 2004).

Methods

The NRA for the FMF follows in general the methods developed by Haener and Adamowicz (2000), but wherever possible, modifications have been made according to the guidelines and recommendations set out in Nordhaus and Kokkelenberg (1999). Components of the FMF NRA include natural resource sector (market) transactions and nonmarket value estimates for recreational use, subsistence use, passive use, and environmental control services. A comprehensive approach is employed that makes use of physical data, traditional economic accounts, and nonmarket estimates. For example, in contrast to Haener and Adamowicz (2000), the FMF NRA includes other commercial accounts such as subsurface mineral resources, agriculture, and the rest of the economy.

For a variety of reasons, 1996 was selected as the base year. First, 1996 is the only year for which data are available for most components. Second, the socioeconomic baseline indicator values in the FMF Local Level Indicators of Sustainable Forest Management Initiative are from 1996 (FMF 2002). Third, using 1996 as a baseline allows application of marginal value estimates for environmental control services from the Haener and Adamowicz (2000) study and thus a comparison of the NRAs for these two Alberta landscapes.

For one measure of sustainability, the FMF NRA examines net regional income, which incorporates the value of flows (goods and services consumed in the most recent year) and accounts for changes in capital stocks. The first step was to quantify, in physical terms, the changes in flows and stocks of natural resource endowments. Some of these data are drawn from the FMF local level indicators database (FMF 2002). The remaining data were collected from the Alberta government, Jasper National Park, and Weldwood of Canada Limited. The second step was to apply appropriate "shadow" or accounting prices (i.e., the marginal value) to determine the component values. Valuing the resource components is not always straightforward, and various methods were employed for this analysis. For example, in the case of nonmarket recreation, there is no market price, so some nonmarket prices that have been estimated for west-central Alberta were used for this study, and other prices were taken from other studies of this or other regions.

In summary, the FMF NRA has the following components:

- market components (forestry, trapping, agriculture, subsurface minerals, visitor-related industries, and the rest of the economy)
- nonmarket components (recreation [i.e., hunting, fishing, and camping], subsistence resource use [i.e., traditional Aboriginal land use], environmental control services [i.e., carbon sequestration] and biodiversity maintenance [i.e., existence of caribou populations]).

The following sections detail value estimates for the FMF NRA components.

Estimates of Component Values

Market Components

Forestry

The Weldwood FMA is the only area in the FMF where commercial harvesting of timber occurs. According to Weldwood's 2002 sustainable forest management plan, with the exception of a small amount of timber (8 500 m3) harvested annually by authority of commercial timber permits within the FMA, Weldwood is the only forest company with tenure on the FMA and authority to manage its timber resource (Weldwood of Canada Limited, Hinton Division, Forest Resource Department. 2002. Sustainable forest management plan. Hinton, AB.) (Table 1).

An estimate of the value of commercial forestry activity in the FMF in 1996 is derived in Table 2. High and low estimates of the marginal value (or economic rent) associated with pulp and lumber production derived from Haener and Adamowicz (2000) were applied to the harvest levels in the region to arrive at values of about $92 million and about $103 million (Table 2). The value of the change in timber stock is presented in Table 3.

Trapping

The FMF is broken down into 80 registered fur management areas (RFMAs), or registered traplines, 64 of which are within the Weldwood FMA (C. Spytz, Weldwood of Canada Limited [Hinton Division], Senior Biologist, personal communication, telephone conversation, October 2002). The RFMAs cover the whole area except national and provincial parks (although

Table 1. Physical account of timber in the Foothills Model Forest, 1996[a]

Forest stock	Deciduous timber (m^3)	Coniferous timber (m^3)
Opening stock	11 152 641	67 460 335
Annual allowable cut	126 000	1 900 000
Removals		
Weldwood harvest	78 437	1 636 152
Land-use changes	10 853	66 667
Fire, insect, disease	1 131	6 949
Additions		
Growth	93 254	1 355 115
Closing stock	11 155 474	67 105 682
Net change in stock	2 833	–354 653

[a]Weldwood of Canada Limited (Hinton Division) provided the estimates of the stock and flow of the timber resource presented in Table 1 (S. Meredith, Weldwood of Canada Limited, personal communication, telephone conversation, March 2003).

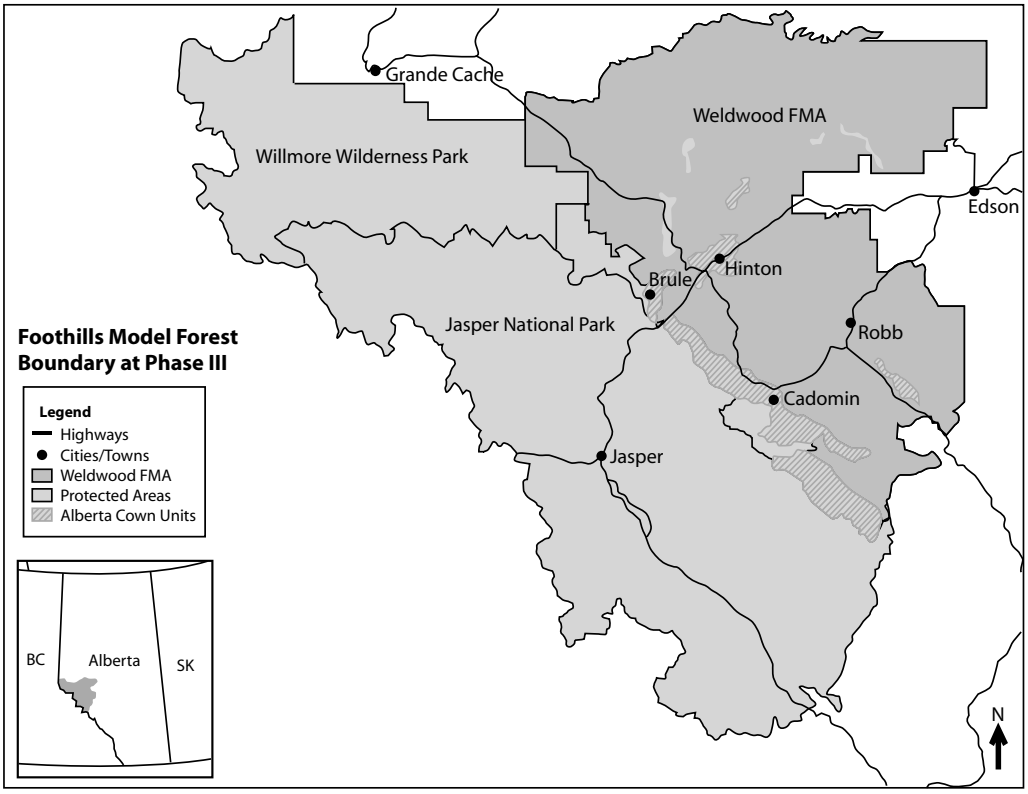

Figure 1. Location of the Foothills Model Forest study region. FMA=Forest Management Agreement.

they do include Willmore Wilderness Park) and townsites but because of the relatively small size of the townsites in the FMF, their areas have not been deducted. Therefore, the total area of the FMF covered by RFMAs is 7 626.14 km^2. In 1996 Westworth, Brunsnyk and Associated Ltd. examined annual trapping income derived from four RFMAs in northeastern Alberta and arrived at an estimate of the trapping revenues generated per unit area (C. Spytz, Weldwood of Canada Limited [Hinton Division], Senior Biologist, personal communication, telephone conversation, October 2002). From 1984–1985 to 1993–1994, the productivity of the RFMAs ranged from $3.86 to $7.22/$km^2$. When this value is applied to the area of RMFAs in the FMF study area, the calculation yields total revenues generated from trapping and associated fur sales of between $30 785 and $57 583 (1996 dollars) (Table 4).

Agriculture

Agriculture, which is a major economic sector in the province of Alberta, is a minor economic sector within the FMF (Alavalapati et al. 1998). There were 32 grazing dispositions occupying 7 987 ha of the land base between 1 June and 31 October 2000 (FMF 2002). Alberta Sustainable Resources Development sets the stocking rate for each disposition on the basis of carrying capacity. In the FMF, 4 324 animal unit months (AUM, the amount of forage required by an animal for 1 month) were allocated, but only 3 634 were grazed, 84% of the maximum sustainable use estimated for the area (FMF 2002).

There is no private agricultural land within the FMF. However, the many farms adjacent to the area affect the FMF economy and are tied to the grazing leases discussed above. The Statistics Canada census boundaries do not correspond directly to the boundaries of the study area, and therefore a broader area of analysis was examined for agriculture; the resulting figures likely overestimate the actual amount of agricultural activity in the FMF economy. According to the 1996 census 830 people were employed in the primary agriculture sector (agricultural industries, service industries, and incidental to agriculture) and 50 people in the secondary agriculture sector (food industries, grain elevator industry, wholesale farm products, wholesale food) in or adjacent to the FMF. Of the 830 people working in the primary sector, 820 lived in the Yellowhead no. 94 census subdivision, and the remaining 10 were located in the Hinton census subdivision. Income generated from the primary and secondary sectors totaled $10 333 145 and $1 383 070, respectively.

According to the 2001 census of agriculture (Statistics Canada 2001), there were 904 farms in the Yellowhead no. 94 census subdivision, comprising 537 326 acres (217 540.9 ha) of the total area. Of this area, 175 636 acres (71 107.7 ha) was devoted to crops, 93 078 acres (37 683.4 ha) to tame or seeded pasture, 183 724 acres (74 382.2 ha) to natural land for pasture, and 84 888 acres (34 367.6 ha) to other uses. This land area is not located directly within the FMF but is reported in this analysis. Table 5 contains detailed economic activity estimates reported in the 2001 census of Agriculture.

The estimated GDP at factor cost for agriculture in the FMF was approximately $18.44 million (Table 6). The net domestic product of agriculture was an estimated $15.03 million, resulting in approximately $3.41 million in depreciation.

Soil erosion is an important environmental component requiring further investigation. However, at the time of this study, no data were available on the extent of changes to principle nutrients for plant growth, soil compaction, nutrient leaching, and other aspects of the soil's physical and chemical condition.

Subsurface Minerals

Subsurface mineral development in the FMF consists primarily of extraction of coal, crude oil, and natural gas. Communities in the FMF were initially founded on coal development. Although coal is not as predominant today as it once was, it remains an important contributor to the mineral sector and the overall economy of the region. Oil and gas activity is greatest in the southeast portion of the area but is limited in the more westerly areas because of the geology and associated costs of production, which rise with proximity to the Rocky Mountains. No oil and gas exploration is permitted in Jasper National Park or the Willmore Wilderness Area.

Limited data were available on the extent of mineral reserves for the region. Production levels were obtained for the three resources, but additions and other depletions of reserves were not readily available. As a result the market components could be characterized, but it was not possible to make adjustments with respect to the stocks of mineral resources.

Table 2. Flow value of pulp and lumber production, 1996

		Low estimate		High estimate	
Product	Harvest (m^3)	Economic rent ($/$m^3$)	Value ($)	Economic rent ($/$m^3$)	Value ($)
HBKP[a]	78 437	36.41	2 855 891	56.71	4 448 162
SBKP[b]	572 653	42.08	24 097 238	59.06	33 820 886
Lumber	1 063 499	60.89	64 756 454	60.89	64 756 454
Total			91 709 583		103 025 502

[a]HBKP = hardwood bleached kraft pulp.
[b]SBKP = softwood bleached kraft pulp.
Note: values are expressed in 1996 dollars. Numbers may not add up due to rounding.

Table 3. Value of change in merchantable timber stock, 1996

		Low estimate		High estimate	
Product	Change in stock	Economic rent ($/$m^3$)	Value ($)	Economic rent ($/$m^3$)	Value ($)
HBKP[a]	2 833	36.41	103 150	56.71	160 659
SBKP[b] + lumber	–354 653	42.08	–14 923 798	60.89	–21 594 821
Total			–14 820 649		–21 434 162

[a]HBKP = hardwood bleached kraft pulp.
[b]SBKP = softwood bleached kraft pulp.
Note: values are expressed in 1996 dollars. Numbers may not add up due to rounding.

Table 4. Value of trapping in the Foothills Model Forest, 1994 and 1996

	Productivity	Value	
Estimate	($/$km^2$)	1994 $	1996 $
Low	3.86	29 437	30 785
High	7.22	55 061	57 583
Mean	5.54	42 249	44 184

Table 5. Reported components of net domestic income from agriculture, 2001[a]

	Amount	
Component	Alberta	Yellowhead no. 94
Labor		
Custom work and contract work	300 371 126	2 634 851
Total wages and salaries	489 253 019	3 224 785
Rental and leasing		
Farm machinery, equipment, andvehicles	68 736 941	405 590
Land and buildings	194 217 537	1 088 889
Repairs and maintenance		
Farm machinery, equipment, andvehicles	435 385 843	4 697 458
Farm buildings and fences	149 349 007	1 891 775
Net domestic income at factor cost (excluding interest earned and profits)	1 637 313 473	13 943 348

[a]Source: Statistics Canada (2001).

In 1996, approximately 16.8 x 10^6 t of coal were extracted from the FMF region. In addition, 3.6 x 10^6 m^3 of natural gas and 31.9 x 10^3 m^3 of oil were produced. Combined, natural gas and oil production translated to 3.3 x 10^6 m^3 of barrel of oil equivalent units (BOE). Table 7 summarizes the available information on subsurface mineral resources for the FMF region.

The estimated net domestic income derived from subsurface minerals was about $256 million. Coal accounts for $174 million (about 68%) and petroleum resources for $83 million (about 32%) of the total. Table 8 summarizes the values associated with flows of subsurface mineral resources from the FMF region.

Visitor-Related Industries

Visitor-related industries comprise transportation, accommodation, food and beverage, retail, and other services. The difficulty in defining a "visitor sector" is that domestic residents also make purchases from these industries (Wellstead et al. 2001). Wellstead et al. (2001) derived an estimate of the economic value of visitors to the FMF economy that distinguished expenditures by visitors from those of local residents. This estimate of visitor expenditures is important because it includes the associated values of commercial recreation that flow from the FMF landscape. For example, the expenditure estimates in Table 9 include the amount that visitors spent at hotels and campgrounds within the FMF.

The Rest of the Economy

The rest of the economy is an aggregate measure of all other commercial activity in the FMF, including components such as domestic services, wholesale goods, and retail sales. Given the various units of measurement, detailed rent estimates were not produced for this sector of the economy. Patriquin et al. (2002) estimated that the value of the rest of the economy in the FMF at approximately $68 820 043. However, that estimate included the value of trapping and agriculture. Deducting the estimates derived in previous sections for trapping and agriculture yields a net value of domestic income for the rest of the economy of $53 740 978.

Market Component Summary

Table 10 summarizes the complete range of estimates for all market activity derived from the FMF in 1996. The estimate of total net income for the region is just over $508.6 million. Subsurface minerals account for 50.4% of the total commercial net income, followed by visitor-related industries at 20.5% and forestry at 15.6% (after adjustment for the drawdown of timber stock).

Nonmarket Components

Recreational Hunting

The nonmarket value of hunting was calculated by valuing the number of days that residents of Alberta spent hunting within the FMF. Hunting activity levels were obtained from the Harvest and Effort by Resident Hunters report series, which has been conducted annually since 1985 by the Fish and Wildlife Division of Alberta Sustainable Resource Development (Alberta Sustainable Resource Development 2004). These reports assess big game and game bird harvests by Alberta resident hunters on the basis of approximately 75 000 telephone surveys each year. A random sample of each license type is generated from the Fish and Wildlife Division's computerized records.

The two license types are general, available to all who are eligible, and special, which are allocated by draws. The special license draws are specific to wildlife management units (WMUs), which means that each special license is limited to a designated WMU. The survey asks hunters which WMU they hunted in, when (i.e., calendar dates), and the number of days they hunted.

To determine the total number of days spent hunting in the FMF, the number of days spent hunting in each WMU that falls completely or partially within the FMF were summed. Twelve WMUs are pertinent to the study area, of which only three are completely within the borders of the FMF. To improve the accuracy of the results, the WMUs that are not completely within the FMF were weighted by the estimated proportion of their surface area that is within the FMF. This weighting is based on the assumption that hunting days are distributed evenly throughout the FMF and each WMU. The results of the survey are also categorized by animal. For this study, days spent hunting for each big game animal in all applicable WMUs were used, but number of days spent hunting for game birds was not included.

Data for 1996 were used because the number of hunting licenses and an estimated nonmarket value of hunting are available for that

Table 6. Estimated value of agriculture in the Foothills Model Forest, 1996

Category	Alberta amount ($)	Yellowhead amount ($)
Calculated net domestic income at factor cost, excluding interest earned and profits (from Table 5)	1 637 313 473	13 943 348
Estimated depreciation	399 850 187	3 405 773
Estimated GDP[a] at factor cost	2 165 000 000	18 440 653
Estimated net domestic income at factor cost	1 765 149 813	15 034 880

[a]GDP = gross domestic product.
Note: values are expressed in 1996 dollars.

Table 7. Physical account of minerals in the Foothills Model Forest, 1996

Mineral stock	Coal (t)	Natural gas (m^3)	Oil (m^3)
Opening stock	Unavailable	66 746 709 200	Unavailable
Removals			
Extraction	16 765 207	3 535 681 000	31 863
Additions			
New discoveries	Unavailable	Unavailable	Unavailable
Closing stock	Unavailable	Unavailable	Unavailable
Net change in stock	Unavailable	Unavailable	Unavailable

Table 8. Flow value of mineral production, 1996

		Estimate	
Product	Extraction	Economic rent ($/unit)	Value ($)
BOE[a] (m^3)	3 342 426	24.7	82 587 647
Coal (t)	16 765 207	10.36	173 679 963
Total	–[b]	–	256 267 609

[a]BOE = barrel of oil equivalent, and it translates natural gas into an oil equivalent measure.
[b]Dashes indicate no calculated total because of different units of measure.
Note: numbers may not add up due to rounding.

Table 9. Flow value of visitor-related services in the Foothills Model Forest, 1996

		Estimate	
Area	No. of visits	Economic rent ($/unit)	Value ($)
Hinton	401 000	83.22	33 370 700
Jasper	2 497 000	28.40	70 912 737
Total	2 537 100		104 283 437

Note: numbers may not add up due to rounding.

year. In 1996, survey respondents spent a total of 26 088 days hunting in the FMF. This information is based on a sample of Alberta hunters, and the data were therefore extrapolated to the entire population. There were 94 639 license holders in the province in 1996 (McFarlane et al. 1998), and approximately 70 000 people (74%) participated in the survey. Therefore, 35 254 (26 088/0.74) days were spent hunting in the FMF by Alberta resident hunters in 1996.

To estimate a value for hunting in the FMF, a value needs to be attached to the participation levels described above. The Adamowicz et al. (1997) study found that willingness to pay (WTP) per trip ranged from $6 to $21 (1996 dollars). To apply this value to activity levels in the McFarlane et al. (1998) study, total days must be converted to total trips. McFarlane et al. (1998) sampled 3 000 Alberta residents who held a moose, elk, or black bear hunting license in 1996 and found that trips lasted an average of 2.31 nights. Therefore, Albertans took an estimated 15 260 (35 254/2.31) trips to the FMF. Combining this value with the WTP estimate from Adamowicz et al. (1997) yields a nonmarket value of big game recreational hunting in the FMF in 1996 of between $91 560 and $320 460 (see Table 11).

Using these data to value recreational hunting in the FMF has a couple of limitations. One problem is that the reports survey only Alberta resident hunters and therefore do not capture the number of days spent hunting by nonresidents, who spend considerable sums of money in travel expenses. Hunting in Alberta, especially in the Rocky Mountains, is a popular tourist activity. For example, in recent years between 1 000 and 1 600 black bear licenses have been sold to nonresidents (ASRD 2002). If the expenditures of nonresidents were included in the analysis, the value of recreational hunting in the FMF would be greater than what is reported here. Therefore, the estimated value of hunting may represent the lower bound of the actual value.

Another limitation to these data is that they consist of only the total number of days Alberta residents spent hunting each year in the FMF and do include the addresses of the hunters. Data on the distance traveled by each hunter would allow for more accurate travel costs to and ultimately a more realistic value of hunting in the FMF. Instead, this study relies on an average estimate of value for all Albertans.

Recreational Fishing

The 1995 Sportfishing in Alberta survey coordinated by the Fish and Wildlife Division of Alberta Sustainable Resource Development provides the most recent source of provincial fishing data. This provincial survey is part of a national survey, the 1995 Survey of Recreational Fishing in Canada, which is the fifth in a series of nationally coordinated studies conducted by Canada's federal, provincial, and territorial fisheries agencies. The surveys have been carried out at 5 year intervals since 1975 to develop an understanding of, and determine trends in, Canada's sportfishery. Berry (1997) has summarized these survey results. At the time of the current study, the 2001 Sportfishing in Alberta survey had been conducted but the results had yet to be analyzed (H. Norris, Alberta Sustainable Resource Development, personal communication, telephone conversation, February, 2003).

The 1995 Alberta questionnaire was mailed to a random sample of 4 578 Alberta residents, 456 other Canadians, and 490 non-Canadians who purchased a sportfishing license in 1995. This results in a total sample of 5 524 out of an estimated total population of 246 113 anglers. Forty-two percent (2 320) of the questionnaires were completed and returned.

The smallest geographic unit of analysis in the survey was the fish management area (FiMA). At the time of the 1995 survey Alberta was divided into eight FiMAs; however, in 1998 these administrative regions were converted to three fish management zones (FMZs). The FMF is completely encompassed by FiMA 4, but Jasper National Park and the Willmore Wilderness Area were not covered by the survey. Because FiMA 4 is larger than the FMF, the statistics reported for FiMA 4 were weighted by the proportion of the FiMA covered by the FMF (approximately 40%). The activity levels for the study area are reported in Table 12.

Haener (1998) noted that using the results of surveys limited to license holders is problematic because youths under 16 years of age, Alberta residents 65 and older, and under the Indian Act Registered Indians are allowed to fish without a license. Berry (1997) reported that 246 113 anglers held Alberta sportfishing licenses in 1995. About 94% of the licensed resident anglers and 96% of the licensed nonresident anglers actively fished.

As well, 100 339 children under the age of 16 living in households of licensed anglers also fished. An estimated 40 000 to 60 000 senior citizens fish annually in Alberta (Berry 1997). The omission of these individuals resulted in undervaluation of fishing in the FMF.

Furthermore, the survey described above does not take into account Jasper National Park or Willmore Wilderness Park. Because fishing data for the latter are difficult to obtain and access to the park is limited, this area has been omitted from the fishing evaluation. Between April and October 2002, 3 213 permits (7-day fishing licenses) and 1 564 annual fishing licenses were sold in Jasper National Park (P. Feldman, Parks Canada, personal communication, telephone conversation, November 2002), and it was assumed that fishing activity level did not vary dramatically over the period 1996 to 2001.

To estimate the average number of days spent fishing by participants who purchased annual licenses in Jasper, the average number of days spent fishing per active angler in Alberta (Berry 1997) was used (Table 13). Annual fishing licenses sold in Jasper were not further subdivided into residents and nonresidents, but for the purpose of deriving an overall estimate of fishing effort in the FMF it was assumed that only residents of Alberta buy annual licenses. Also, it was assumed that those who purchase 7-day licenses fish for the full 7 days. Therefore, the estimated number of days spent fishing in Jasper National Park was 48 297 [(16.5 days per angler x 1 564 annual licenses) + (7 days per angler x 3 213 7-day licenses)].

Thus, a total of 180 866 (130 320 for Alberta residents [Table 12] + 2 249 for nonresidents [Table 12]+ 48 297 for Jasper National Park) days were spent fishing in the FMF in 1995.

Recreational fishing days were valued at the rate used by Haener and Adamowicz (2000), and in 1995 the value of recreational fishing in the FMF was estimated at between $0.37 and $1.89 million (Table 14).

According to Alberta Sustainable Resource Development, there is currently no commercial fishing within the FMF (K. Bodden, Provincial Commercial and Domestic Fisheries Specialist, personal communication, telephone conversation, November 2002).

Camping

The FMF offers a rich variety of recreational opportunities that make it a popular camping destination. Designated campsites are available in Jasper National Park and Weldwood's FMA. Backcountry camping occurs in both of these locations, as well as in Willmore Wilderness Park. Camping is a good indicator of recreational use because of its prominence in terms of the number of users and its distribution throughout the FMF, and also because campers generally engage in multiple recreational activities such as fishing and hiking while staying in the forest (McFarlane et al. 1996). Over the past 5 years, management and maintenance of a number of public campgrounds and recreational sites within Weldwood's FMA have been turned over to partnerships between Alberta Community Development (Parks and Protected Areas), Weldwood, and the Fox Creek Development Association.

To estimate of the value of camping in the FMF, data on the number of people camping in provincial campgrounds within the area for 1998 and 1999 were taken from the 1997–1998 and 1998–1999 Visitation Statistics: Provincial Parks and Recreation Areas report series prepared by the Parks and Protected Areas Division of Alberta Sustainable Resources Development (Alberta Environmental Protection 1998, 1999). This information is based on camping permits, both standard and self-registration, and also periodic surveys of camping party size. The reports define number of campers as the average camping party size multiplied by the number of occupied campsite nights. On average, the estimated number of campers per year in the FMF outside of Jasper is 75 640.

Statistics for all campsites in the FMF were not readily available. For campgrounds not included in the survey, the number of campers was estimated by applying the average number of campers per campsite at all of the campgrounds reported in the surveys to the number of campsites at each campground that was not surveyed. Whitehorse Wildland Park is located in the FMF but does not offer designated camping and as such it is not considered in the valuation procedure. Little information was available on the private campgrounds located in or near Hinton, other than the number of sites (about four). For two of the campgrounds, Roundcroft and Maskuta, estimates were derived from averages for the

Table 10. Summary of commercial accounts for the Foothills Model Forest, 1996

Component[a]	Mean value ($, thousands)	% of net income from commercial sources
Forestry		
Flow value	97 368	19.1
Change in timber stock	–18 127	–3.6
Subtotal	79 240	15.6
Other sectors		
Trapping	44	0.01
Agriculture	15 035	3.0
Subsurface minerals	256 268	50.4
Visitor-related industries	104 283	20.5
Rest of the economy	53 741	10.6
Subtotal	429 371	84.4
Total	508 611	100

[a]Accounting adjustments have not been made for natural resource sectors other than forestry because of a lack of data. The proportional contribution of the commercial forest sector would likely be much larger if depreciation of subsurface mineral stocks and agricultural soils had been considered. However, the adjustment for the commercial forest sector highlights the difference that natural resource accounting can have on estimates of net income.
Note: numbers may not add up due to rounding.

Table 11. Nonmarket value of recreational hunting in the Foothills Model Forest, 1996

Estimate	WTP[a] per trip ($)	Hunting trips	Value ($)
Low	6	15 260	91 560
High	21	15 260	320 460

[a]WTP = willingness to pay.

Table 12. Fishing activity levels in the Foothills Model Forest, 1995[a]

No. of fishing days in FiMA 4[b]			Proportion of FMF covered by FiMA 4	No. of fishing days in FMF[c]		
Alberta residents	Non-residents	Total		Alberta residents	Non-residents	Total
325 800	5 623	331 423	0.4	130 320	2 249	132 569

[a]Source: Berry (1997).
[b]FiMA 4 = Fish Management Area no. 4.
[c]FMF = Foothills Model Forest.

Table 13. Fishing effort in Alberta, 1995[a]

Variable	Alberta residents	Other Canadians	Non-Canadians	Total
Total days fishing	3 629 119	57 174	28 451	3 714 744
No. of licensed active anglers	219 807	6 319	6 339	232 465
Average days per active angler	16.5	9	4.5	16.0

[a]Source: Berry (1997).

other campgrounds, as described above; however, the averages for other campgrounds could not be applied to Folding Mountain Campground because the latter facility offers more amenities than most other campgrounds in the FMF (e.g., showers).

Using this information to determine the value of camping in the FMF may be questionable. The addresses of the campers were not reported, but it is likely that many of the campers, particularly Jasper National Park campers, were nonresidents of Alberta or even Canada. Most camping values derived in the past have attempted only to determine a nonmarket value for residents; applying this value to nonresidents would cause the value of camping in the FMF to be underrepresented. The reason nonresidents are often overlooked is the "high probability of multiple destinations for most visitors not residing in Alberta" (Haener and Adamowicz 2000).

Jasper National Park was not included in the survey visitation statistics described above. According to Parks Canada, Jasper receives approximately 150 000 campers per year (P. Feldman, Parks Canada, personal communication, telephone conversation, October 2002). When this number is summed with the 1998 and 1999 estimates, the estimated average number of campers to the FMF outside of Jasper (150 000) is 75 640. Combined the total number of campers in the FMF in a year is 225 640.

To determine the nonmarket value of camping in the FMF, a value must be attached to the activity levels. Several studies have been conducted to determine the value of a camping trip to Alberta residents. In 1995 McFarlane and Boxall (1998) collected registration envelopes from 15 provincial recreation areas and 5 campgrounds in the FMF. A value of $58.14 per trip to the FMF was estimated on the basis of a travel cost model. This was aggregated over 7 510 trips taken by Albertans to arrive at an estimated value of $436 631 for the service flow associated with camping at the formal sites in the FMF in 1995. A similar study conducted by Boxall et al. (1996) determined that a camping trip to southern Alberta was worth $52.77 for an Alberta resident. Although this value is similar, the former value ($58.14) was deemed more applicable to the current study because of location.

To apply this value to the current study, the number of campers must be converted to number of trips. McFarlane and Boxall (1998) determined that campers in the FMF spend 1.88 nights at the campgrounds; thus, an average of 120 021 trips were made in both 1998 and 1999 (225 640/1.88). The number of trips estimated here is far greater than that estimated by McFarlane and Boxall (1998) mainly because Jasper National Park, which accounts for 66% of the number of campers, was included in this study but not the earlier one. The estimated value for the service flow associated with camping in the FMF for both 1998 and 1999 was almost $7 million in 1995 dollars (Table 15).

Traditional Resource Use by Aboriginal Peoples

The FMA is covered by two treaties, Treaty 8 to the north of the Athabasca River and Treaty 6 to the south. These treaties spell out agreements between the federal government and the First Nation bands, including the right to continue traditional activities within the forest area (Weldwood of Canada Limited, Hinton Division, Forest Resource Department. 2002. Sustainable forest management plan. Hinton, AB.). The 1991 and 1996 Aboriginal population estimates for the 3 census subdivisions of the FMF, as reported by Statistics Canada, are contained in Table 16.

Using these populations to determine participation levels in subsistence use has limitations. According to Weldwood, the area was historically used by about 17 different Aboriginal groups, but today only 6 Aboriginal groups use the area: Aseniwuche Winewak Nation, Alexis Band, Paul Band, O'Chiese First Nation, Sunchild First Nation, and the Stoney Tribe (D. Kmet, Weldwood of Canada Limited, Coordinator, Lands and Aboriginal Affairs, personal communication, telephone conversation, November 2002). The Alexis Band is the only group with reserves that fall within the FMF; however, other groups also use the FMF and thus should be considered in determining the value of the FMF in terms of subsistence use.

The Department of Indian Affairs and Northern Development (DIAND) is required by the Indian Act to record in the Indian Register the names of individuals who are registered under the act. Using the register to determine the population of Aboriginal peoples in the study area may not be completely accurate because the register covers only those who have applied to be registered and whose entitlement has been verified. The data are

based on registry groups. A registry group is an administrative term applied to a group of Indian Register individuals who have membership in a particular Indian band or are descendants from members of that band (DIAND 2002).

The population statistics in Table 17 are based on the Indian Register and include individuals on reserve, off reserve, and on Crown land. The total 1996 Aboriginal population determined by the census (Table 17) is close to the estimate provided by DIAND (2001) for the Alexis Band. The average number of individuals per household was calculated from the 1991 provincial average Indian Reserve household size, 4.5 (Statistics Canada 1991). There are no Métis Settlements in the vicinity of the study area.

Participation rates in subsistence fishing cannot be inferred by examining license sales because "Status or Treaty Indians are allowed to hunt and fish for subsistence purposes without a license" (MacLock and Thompson 1996). However, a domestic fishing license is required by all Indians wishing to fish for food with a net. This license is free and can be obtained at any Fish and Wildlife Service office. Fishing for free, with or without a net, requires that all fish caught be used for subsistence purposes only and be distributed only to family or household members.

Estimating participation in subsistence trapping is also difficult because although Métis and Indian trappers must be licensed, the number of licenses issued does not reflect whether the fur and meat obtained from these traplines is used for subsistence or commercial purposes (Haener 1998).

To date, no studies have been conducted to determine the monetary value of resources used for traditional activities within the FMF, although the FMF is working to start such a program. Also, in October 2001, Weldwood sponsored a gathering of elders of the various Aboriginal groups, in partnership with the FMF. One of the outcomes was support for a traditional and cultural study. Because no studies have determined a value for subsistence use in the area, the current study has relied on replacement values. Haener and Adamowicz (2000) used replacement values, obtained by imputing prices based on the closest substitutes to harvest products available in the nearest market, to arrive at a value of $5 000 to $11 000 per household, depending on the location and variety of activities valued.

This estimated value was combined with the number of Aboriginal households in the study area to yield a value for the subsistence activity within the study region of between $9.9 million and $21.7 million in 1997 (Table 18).

There are limitations to using replacement values as a means of estimating the value of subsistence or noncommercial uses of the forest by Aboriginal people, in that replacement values may not capture the cultural value of the activities. There may not be substitutable commodities that could compensate for what would be lost if the opportunity to hunt and trap were lost to indigenous people whose ancestors lived in the same place and practiced the same activities for thousands of years before them (Beckley and Hirsch 1997). The comparison of subsistence goods with store-bought replacements assumes that consumers are indifferent to whether they have market goods or subsistence goods; however, Beckley and Hirsch (1997) found that, in general, subsistence goods are preferred over store-bought substitutes.

Maintenance of Biodiversity

Several studies in the past decade have attempted to measure passive-use values. One such study (Hulkrantz 1992) used the cost of forgone timber income associated with increasing the amount of protected area as an estimate of the value of the change in biodiversity. Haener and Adamowicz (2000) rejected this method because it was based on the assumption that biodiversity is declining, and instead based the estimated value on current levels of biodiversity. Following Haener and Adamowicz (2000), this study estimated the value of biodiversity using two methods, the first based on individuals' average WTP for the preservation of woodland caribou and the second based on valuing biodiversity as the opportunity cost of the actions taken to protect it.

Willingness to Pay

The only species within the FMF that is designated as threatened by the Alberta Wildlife Act is the woodland caribou (*Rangifer tarandus*). These caribou are likely to be extirpated in Alberta if the factors causing reductions in their numbers are not reversed. The Committee on the Status of Endangered Wildlife in Canada has also classified the woodland caribou as threatened. Several studies have been conducted throughout Canada to estimate a WTP to enhance the species' population (Tanguay et al. 1993; Adamowicz et al. 1999).

Table 14. Nonmarket value of recreational fishing in the Foothills Model Forest, 1995

Estimate	Willingness to pay estimate ($/day)	No. of days	Value ($)
Low			
Resident[a]	2.00	178 617	357 234
Nonresident	6.00	2 249	13 494
Total			370 729
High			
Resident[a]	10.22	178 617	1 825 466
Nonresident	30.66	2 249	68 960
Total			1 894 426

[a]Includes Jasper National Park.
Note: estimates may not add up due to rounding.

Table 15. Nonmarket value of camping in the Foothills Model Forest (FMF), 1998 and 1999 combined

Area	Camping trips	Cost/trip ($)	Total value ($1995)	Total value ($1996)[a]
FMA	40 234	58.14	2 339 205	2 390 668
Jasper	79 787	58.14	4 638 816	4 740 870
Total for FMF	120 021	58.14	6 978 021	7 131 538

[a]Consumer price index for Alberta was used as the conversion factor.
Note: FMA = Weldwood Forest Management Agreement area.

Table 16. Aboriginal population of the case study region[a]

Census subdivision	Total population	Aboriginal population	% Aboriginal
Hinton	9 960	725	7.3
Jasper	4 260	105	2.5
Yellowhead 94	9 350	620	6.6
Total	23 570	1 450	6.2

[a]Source: Statistics Canada (1996).
Note: numbers may not add up due to rounding.

Table 17. Registered Indian populations in the Foothills Model Forest, 2001[a]

First Nation or band	Population	Households
Alexis	1 360	302
Aseniwuche Winewak Nation	450	100
O'Chiese First Nation	745	166
Paul Band	1 564	348
Sunchild First Nation	851	189
Stoney Tribe		
Bearspaw Band	1 200	267
Chiniki Band	1 292	287
Wesley Band	1 417	315
Total	8 879	1 974

[a]Source: DIAND (2002).

Because of similarities in geographic location, the estimate calculated by Adamowicz et al. (1999) is more suitable for the FMF. That study examined the value associated with enhancing the population of the woodland caribou in west-central Alberta using both the contingent valuation method (CVM) and choice experiments (CE). Although the study did not identify a specific herd, it did state that the caribou were of the mountain ecotype, the same ecotype that winters partially within the Weldwood FMA area. The resulting estimates were for Edmonton households. The results of the CVM revealed that households were willing to pay about $140 per year to preserve the woodland caribou, which is more than the estimated $75 determined by the CE method. Adamowicz et al. (1999) stated that their analysis revealed that the CE approach provides a richer description of preferences over environmental attributes and thus may be superior to the CVM.

According to the 1996 census, the population of Alberta was 2 696 826 in 1996, and there were 984 275 households. Applying both the low and high estimates to the number of Alberta households leads to a provincial annual existence value between $72.8 million and $138.8 million (Table 19).

Haener (1998) discusses one important consideration in using this method: To arrive at an estimate of the net value associated with caribou protection, the costs of ensuring protection should be subtracted from the WTP estimate. Within Weldwood's FMA several protective measures have been taken. For example, a combined initiative of Weldwood and the West-Central Alberta Caribou Standing Committee identified a Special Management Area (SMA) for the portions of the A La Peche caribou herd that occurs within the Weldwood FMA (Weldwood of Canada Limited, Hinton Division, Forest Resource Department. 2000. 1999 forest management plan: Vol. 1. Management strategy 1999–2008. Hinton, AB.). Within the SMA, the compartment schedule originally proposed in Weldwood's 1991 Forest Management Plan was altered, and harvest rates were significantly reduced and concentrated to minimize impacts on caribou. It would be very difficult to determine the costs of these measures, as doing so would require a comparison of Weldwood's financial situation with and without these costs.

Opportunity Cost

The opportunity cost approach, the second approach taken by Haener and Adamowicz (2000), estimates the value of benefits forgone by the company to preserve biodiversity. This method assumes that the costs to the company in terms of timber income forgone represent a lower bound on the benefits received from these efforts, meaning that the benefits at least equal the costs (Haener and Adamowicz 2000).

As of 31 December 1996, a total of 262 174.6 ha had been included as part of the protected land base within the FMA, including 9 519 ha that had been legally protected (Weldwood of Canada Limited, Hinton Division, Forest Resource Department. 2002. Sustainable forest management plan. Hinton, AB.). It is assumed that the protected area land base has the same proportion of merchantable timber as the overall region (71.6%). Therefore, 187 717 ha (262 174.6 x 0.716) is the area of protected land that is valued using the opportunity cost method.

In 1999, the mean annual timber increment (MAI), or annual growth, was 2.71 m^3/ha for the coniferous stands (1 936 067 m^3/715 341 ha) and 0.21 m^3/ha for the deciduous stands (151 823/715 341 ha). It was assumed that the annual growth of the merchantable stocks was equivalent to that of the protected areas and also that the MAIs in 1999 were the same as in 1996. Therefore, the annual amount of coniferous and deciduous timber that Weldwood is forgoing by setting this area aside for protection is about 437 493.2 m^3 (187 717 x 0.86 x 2.71) and 5 519 m^3 (187 717 x 0.14 x 0.21), respectively. Table 20 combines these volumes with the range of rents used by Haener and Adamowicz (2000) to arrive at an estimated value for timber income forgone as a result of protected areas ranging from about $16 million to about $25 million.

Haener and Adamowicz (2000) incorporated an additional cost associated with preserving biodiversity, the loss in AAC from the operational requirements of implementing ecosystem management. Haener and Adamowicz (2000) netted out 5% of deciduous AAC and 1% of coniferous AAC; however, Weldwood has stated that these costs are already included in their AAC (S. Merideth, Weldwood of Canada Limited, personal communication, e-mail and telephone conversation, March 2003).

Environmental Control Service: Carbon Sequestration

Carbon storage in forest ecosystems is increasingly viewed as a criterion of sustainable forest management. In recent years there has been increasing interest in the use of forests as a means of mitigating the accumulation of carbon dioxide (CO_2) in the atmosphere (Hoen and Solberg 1994). Policymakers are acknowledging the role of forests by allowing the uptake of carbon in terrestrial ecosystems to be charged against emissions from industrial sources. Thus, it appears that forests offer another type of benefit, in the form of a storage device for carbon that could otherwise contribute to the accumulation of CO_2 in the atmosphere. It is important to incorporate the value of carbon sequestration into the NRA of the FMF.

In an attempt to help local forest managers assess the effects of plausible management strategies on the local forest carbon budget, Apps constructed a carbon budget for the forested area of Weldwood's FMA that was included in the company's 1988 inventory (820 657 ha) (Apps, M.J. 1997. Estimating the annual carbon budget of the Foothills Model Forest. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, AB. Working Paper.). The Apps working paper determined that the net volume of carbon stored in Weldwood's FMA in 1988 was 689 422 Mg C yr^{-1}. This number includes the net transfers of carbon to wood products, most of which leave the FMF. As pointed out in the Apps working paper, these transfers were extremely small in 1988 (about 2 700 Mg C yr^{-1}); primarily because before 1988, most of the harvested material went into pulp products and landfill disposals; however, in more recent years, it is likely that net transfers to wood products have increased, which implies that more sequestered carbon is being shipped out of the FMF to other areas. (Although conclusions from the report are based on inventory collected over a decade ago, the inventory in 1999 grew by only 12%, to 917 792 ha [Weldwood of Canada Limited, Hinton Division, Forest Resource Department. 2002. 1999 Forest Management Plan: Vol. 2. Resource Analysis. Hinton, AB.]. In fact, Weldwood's 1999 Detailed Forest Management Plan [DFMP] reported that the periodic allowable cut control for the 1988–1993 period was exactly the same as for the 1993–1998 period [9 500 000 m^3], and over the 10-year period as a whole [1988–1998], only 78% of the total periodic allowable cut was harvested. In the Apps working paper, a sensitivity analysis showed that the effects of increasing harvesting levels by 10–25% reduce total storage in the short run; but that over time, as the younger, faster-growing stands that replaced the relatively unproductive old-growth forest reach maturity, the long-term differences in total ecosystem carbon resulting from different harvesting levels gradually diminish. An exception to this general rule occurs if the harvest rate is reduced by more than 25% of the planned rate, in which case long-term ecosystem carbon storage is significantly increased; however, it is unlikely that Weldwood has increased the harvest rate beyond 25% since 1988. Therefore, it is very unlikely that the carbon storage capacity has been greatly altered since 1988.)

As mentioned by Haener and Adamowicz (2000), other factors such as fuel and energy use by mills and vehicles must also be considered. Apps was unable to obtain data on the emissions of CO_2 and other greenhouse gases from Weldwood's forest management and harvesting operations but reported that it is reasonable to assume that the fossil energy consumption associated with forest operations and sawmilling represents a relatively small fraction of the current annual net uptake of CO_2 by the forest ecosystem (Apps, M.J. 1997. Estimating the annual carbon budget of the Foothills Model Forest. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, AB. Working Paper.).

In recent years the valuation of carbon sequestration has received considerable attention. Because of the uncertainty of future emission levels, valuing carbon sequestration is difficult. Haener and Adamowicz (2000) assumed that the value to society of carbon sequestration services provided by the forest could be approximated by the abatement costs avoided (i.e., costs of abating greenhouse gases by other methods). On the assumption that the level of marginal damages is increasing at a rate less than the social discount rate, Haener and Adamowicz (2000) used an annual flow value range from $16.60/t C to $0.34/t C, which yields a value of carbon sequestration services in 1996 of between $0.23 and $11 million (Table 21).

Nonmarket Component Summary

Table 22 summarizes the nonmarket accounts for the FMF in 1996. The total net income estimate derived for nonmarket benefit flows from the region is almost $107 million. Biodiversity conservation accounts for 72.1% of the total nonmarket net income, followed by traditional resource use at 14.5% and camping at 6.7%.

Table 18. Value of subsistence activity in the Foothills Model Forest, 1997

Estimate	Value/ household	Total for FMF (1997 $)	Total for FMF (1996 $)
Low	5 000	9 870 000	9 671 699
High	11 000	21 714 000	21 277 737

Note: a conversion factor of 1.021 was used for 1997, deflated by a consumer price index of 1.021 to 1996 dollars.

Table 19. Existence value of caribou among Alberta residents, 1996

Estimate	WTP[a] / household ($)	No. of households	Total value ($)
Low	75	984 275	73 820 625
High	140	984 275	137 798 500

[a]WTP = willingness to pay.

Table 20. Opportunity costs of protected areas in Weldwood's protected land base, 1999

		Low estimate		High estimate	
Type of timber	Volume forgone (m^3)	Rent estimate ($/$m^3$)	Value ($)	Rent estimate ($/$m^3$)	Value ($)
Coniferous	437 493	36.41	15 929 120	56.71	24 810 228
Deciduous	5 519	42.08	232 239	60.89	336 052
Total			16 161 359		25 146 280

Note: numbers may not add up due to rounding.

Table 21. Value of sequestered carbon in the Weldwood Forest Management Agreement area, 1996

Carbon sequestered[a] (t)	Low estimate ($0.34/t C)	High estimate $16.60/t C
689 422	$234 403	$11 444 405

[a]1 Mg C = 1 t C.

Table 22. Summary of nonmarket accounts for the Foothills Model Forest, 1996

Component	Mean value[a] ($, thousands)	% of net income from nonmarket sources
Recreational use		
Hunting	206	0.2
Fishing	1 133	1.1
Camping	7 132	6.7
Subtotal	8 470	7.9
Subsistence use (traditional resource use)	15 475	14.5
Passive use (biodiversity maintenance)	76 980	72.1
Environmental control service (carbon sequestration)	5 839	5.5
Total	106 764	100

[a]The mean value for biodiversity maintenance was calculated from the lowest and highest estimate derived from the opportunity cost method and the willingness to pay method [(16 m + 137 m)/2].
Note: numbers may not add up due to rounding.

SUMMARY AND IMPLICATIONS

The total net income of the forest resource and associated landscape in the FMF for 1996 was estimated at $615.4 million (Table 23). The largest single component of the net regional income was the extraction of subsurface minerals (41.6%). However, the depreciation of the initial stock of the resource has not been accounted for in this figure. The visitor sector provided the next greatest contribution to net income (16.9%), followed by the forestry sector (12.9%) and biodiversity maintenance (12.5%). Overall, market activities contributed 82.7% to the welfare generated from the landscape, and nonmarket components contributed the remaining 17.3%.

The forest resource contributes significantly to the welfare derived from the FMF. Not only does the forest provide a direct welfare benefit of $79 million in terms of commercial timber production, but it also provides another $107 million indirectly in the form of nonmarket components. In total, the forest resource contributed $186 million (30.2%) to the FMF regional net income.

The landscape examined by Haener and Adamowicz (2000) was comparable to the FMF in terms of land area and AAC. A comparison with their results demonstrates the varying level of forest benefits derived from different forest landscapes (Table 24). For example, commercial fishing and trapping and the nonmarket benefits of carbon sequestration were more predominant in the Haener and Adamowicz (2000) study. The estimated nonmarket benefits of camping and biodiversity maintenance were substantially greater in the FMF region. Overall, the commercial component of forestry was greater in the Haener and Adamowicz (2000) study, and the nonmarket components provided a greater contribution of total net income in the FMF. This reflects the diversity of benefit streams derived from the FMF landscape.

A forest management plan is required for every established Forest Management Unit of provincial Crown land. FMA holders assume this responsibility from the government and must prepare a Detailed Forest Management Plan (Alberta Sustainable Resource Development 2004). While traditional forest planning has emphasized sustained-yield timber management, government policy also recognizes other resource values and uses. Socioeconomics and the flow of benefits to society constitute one of the subject areas that may be considered for the purpose of defining specific management objectives in the management plan.

The FMF NRA described here provides an innovative framework for detailing a variety of benefits that society derives from a forested landscape. The information in this NRA represent a baseline of values that can be used to assess the progress of Weldwood of Canada Limited toward specific objectives related to resource management goals. In addition, these baseline indicator levels can be reported in the FMF Local Level Indicators of Sustainable Forest Management Initiative.

Natural resource accounting is a relatively inexpensive and innovative method of assessing benefits flowing from a landscape and should be considered by government and industry for inclusion in various planning initiatives such as Detailed Forest Management Plans and regional integrated resource management initiatives.

The FMF NRA represents a significant gain in knowledge with respect to the welfare gained from the landscape, but it is not comprehensive in terms of adjustments to market activities and inclusion of nonmarket benefits. For example, the lack of data on adjustments for subsurface mineral deposits in the region represents a gap in the adjustments to market activities. The quantity and quality of water resources are becoming issues of concern in the province of Alberta and its regions. No attempt was made to cover water resources in this study, and this remains an important area for future research. Another limitation of this study is the application of marginal value estimates derived for other regions to the component value estimation for the FMF. Region-specific studies would improve the estimates derived for the nonmarket components. Despite these limitations, the FMF NRA focuses on some of the important forest and landscape services in the region. The FMF NRA also provides an important baseline of information that can be tracked over time to assess sustainability in the region.

Table 23. Summary of the natural resource account for the Foothills Model Forest, 1996

Component	Mean value[a] ($'000s)	% of net income from all sources
Market		
Forestry		
Flow value	97 368	15.8
Change in timber stock	–18 127	–2.9
Subtotal	79 240	12.9
Other sectors		
Trapping	44	0.01
Agriculture	15 035	2.4
Subsurface minerals	256 268	41.6
Visitor-related industries	104 283	16.9
Rest of the economy	53 741	8.7
Subtotal	429 371	69.8
Market subtotal	508 611	82.7
Nonmarket		
Recreational use		
Hunting	206	0.03
Fishing	1 133	0.2
Camping	7 132	1.2
Subtotal	8 470	1.4
Subsistence use (traditional resource use)	15 475	2.5
Passive use (biodiversity maintenance)	76 980	12.5
Environmental control service (carbon sequestration)	5 839	0.9
Nonmarket subtotal	106 764	17.3
Total	615 375	100

[a]Values are expressed in 1996 dollars.
Note: numbers may not add up due to rounding.

Table 24. Comparison of regional forest resource accounts in Alberta

Component	Mean value ($ 1996) (and %)			
	FMF (this study)		Haener and Adamowicz (2000)	
Market activities				
Commercial forestry				
Value flow	97 368	(52.3)	91 480	(39.4)
Change in timber stock	–18 127	(9.7)	52 335	(22.5)
Subtotal	79 240	(42.6)	143 815	(61.9)
Trapping	44	(0)	394	(0.2)
Fishing	0	(0)	286	(0.1)
Nonmarket activities	79 284	(42.6)	144 495	(62.2)
Recreational use				
Hunting	206	(0.1)	621	(0.3)
Fishing	1 133	(0.6)	1 583	(0.7)
Camping	7 132	(3.8)	212	(0.1)
Subtotal	8 470	(4.6)	2 417	(1.0)
Subsistence use (traditional resource use)	15 475	(8.3)	17 576	(7.6)
Passive use (biodiversity maintenance)	76 980	(41.4)	58 430	(25.1)
Environmental control service (carbon sequestration)	5 839	(3.1)	9 529	(4.1)
Nonmarket subtotal	106 764	(57.4)	87 953	(37.8)
Total net forest income	186 049	(100)	232 448	100

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