Accounting for Natural Capital in BC: Forestry and Conflict in the Slocan Valley

by

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B.I.S University of Waterloo 1987

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTER OF ARTS

Interdisciplinary Degree by Special Arrangement

We accept this thesis as conforming
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ABSTRACT

BC's timber industry appears to be unsustainable. Government has drawn on economic analysis applied in a Multiple Accounts framework to reduce social conflict and arrive at more rational forest management decisions. Such studies report income in a way inconsistent with its Hicksian definition reinterpreted in a "full" world. This inconsistency and related deficiencies favour industrial forestry over ecosystem-based approaches.

Building on Hicksian income and a societal commitment to sustainable development, I propose that economic analysis of renewable resource extraction be required to account for natural capital through an "interest/depletion" approach, whereby scenarios are evaluated against an ecosystem-based baseline.

Applying these proposals to BC's Slocan Valley, where a struggle to protect ecosystems from industrial forestry culminated in civil disobedience, I illustrate how economic consequences are recast in a way relevant to sustainability. Political economy considerations temper the prognosis: values, perspectives, and interests are diverse and contested; power is concentrated; reform unlikely.

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On behalf of the Silva Forest Foundation:

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On behalf of Jason Kubian:

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LIST OF ACRONYMS

AAC	Annual Allowable Cut
CBA	Cost-Benefit Analysis
CORE	Commission on Resources and the Environment
FEN	Forest Ecosystem Network
GIS	Geographic Information System
KBLUP	Kootenay-Boundary Land Use Plan
KBLUP-IS	Kootenay-Boundary Land Use Plan Implementation Strategy
LTHL	Long Term Harvest Level
LRESY	Long Run Ecologically Sustainable Yield (as per SFF)
LRSY	Long Run Sustained Yield (as per MoF)
MAA	Multiple Accounts Analysis
MLA	Member of the Legislative Assembly
MoF	Ministry of Forests
MSY	Maximum Sustained Yield
NDP	New Democratic Party
PSYU	Public Sustained Yield Unit
RA	Resource Analysis or Resource Appraisal
SEIA	Social and Economic Impact Assessment
SFF	Silva Forest Foundation
SRESY	Short Run Ecologically Sustainable Yield (as per SFF)
SVCFMP	Slocan Valley Community Forest Management Project
SVEAPRS	Slocan Valley Equal Access to Public Resources Society
TFL	Tree Farm License
TSA	Timber Supply Area
TSR	Timber Supply Review

ACKNOWLEDGMENTS

In researching and writing this thesis, I have had the odd experience of never having done anything for an extended period of time that was at once so solitary and yet so public. I have many people to thank, both inside and outside of the university.

To begin, I would like to thank Professor Rod Dobell for his encouragement, for the time he has put into this project, for his frequent dispatches of relevant research to be incorporated, and, in particular, for agreeing to take over the position of supervisor midway through my Master's program. Thanks also to the two other members of my committee, Professors Jack Ruitenbeek and Duncan Taylor. Thanks to Professor Michael M'Gonigle for providing funding through the Eco-Research Chair of Environmental Law and Policy for my earlier graduate work at UVic. I also benefited from the insightful comments of my external examiner, Dr. Nancy Turner, whom I thank for her perseverance in thoroughly reviewing this tome, and adding an invaluable perspective. Although they were not involved in the thesis part of my Master's degree program, the influence of Professors Herman Daly, Robert Costanza and Peter Brown of the University of Maryland at College Park (with whom I studied for the first term of my graduate studies) will be obvious to those who are familiar with their work. Professor Stan Rowe provided helpful comments on Chapter 3 of this thesis.

Amongst fellow grad students, Cheri Burda deserves mention, for setting high standards in practical scholarship, for her unflagging sense of humor and for reminding me of the enthus-o-meter at a critical moment; Jen Bonnell continues to inspire me with her devotion to making forestry both more ecologically sound and respectful of First Nations' rights, all the while retaining such optimism and love of life; and Juliet Craig for introducing me to Nelson. Friends who were of particular assistance in this project include Adrian Ruigrok, Susan Hollier, Bernie Gaudet, Marie-Paul Brisson, and Sebastian DeMarre. Wendy

Philleo unwittingly sent me off down the grad school route (readers may dispute whether or not she deserves thanks on this account). Thanks to Dawn Eimer for diligent word-processing.

In the Slocan Valley, I would like to thank Herb and Susan Hammond of the Silva Forest Foundation for making Silva's resources freely available, as well as for their hospitality. Thanks too for feedback and other assistance from Tom Bradley, Angela Hawe, and Colleen McCrory.

In Nelson, I would like to thank many of the people who made up the core of the Ecocentre, where I rented office space; and, in particular, Suzy Hamilton, Jack Ross, and Matt Lowe.

Thanks too go to many individuals with the Ministries of the Environment and Forestry, as well as to others involved in forestry in various capacities, for providing material and for constructive criticism. I am indebted to the following people: Pamela Dykstra, Tom Braumandl, Steve MacAdam, Jason Kubian, Tom Dool, Mike Stone, Stephanie Frioud, Mike Major, LeeAnn Chevrette, Jim Cooperman, and the folks at the Sierra Legal Defense Fund.

Without the support of my family, and in particular my parents, Les and Marion Green, this thesis would never have been completed.

Despite the broad base of individuals on whose knowledge, wisdom or generosity I have drawn, I suspect that many of those whose names appear above would have reservations with portions of this thesis. Of course, the content is my sole responsibility.

Chapter 1: Introduction: Ecological Limits, Economic Analysis and Social Conflict

1.1 Background: Outline of a Controversy

Many observers suggest that current levels of renewable resource extraction across the globe are, with rare exceptions, unsustainable (Ludwig et al., 1993; Worldwatch, 1995). This case has been forcefully argued with respect to the timber industry in the province of BC. Analysts claim, with considerable evidence to support their position, that the rate and method of timber extraction are resulting in serious ecological deterioration, and will lead to much lower future timber outputs (M'Gonigle and Parfitt, 1994:31; Hammond, 1991; BC Forest Sector Strategy Committee, 1995:8). Yet the provincial government appears unable or unwilling to enact a shift from industrial forestry to ecosystem-based forestry (M'Gonigle, 1997; Sierra Legal Defense Fund, 1996a, b; Zirnhelt, 1996).

Given that all economic activity--indeed, all human activity--depends ultimately on functioning ecosystems, communities, governments and societies will suffer in the long term if they allow their stock of renewable resources to be depleted and local ecosystems to be degraded (Daly, 1977). Analytically, this is equivalent to the assertion that there exist critical stocks of natural capital for which there cannot be adequate produced substitutes. Some regions may continue to prosper despite locally degraded environments by importing and processing resources from other regions, thereby drawing on the natural capital of other regions. However, given worldwide overharvesting, this latter option is not a solution to the fundamental problem. Overall, it is claimed, renewable resource extraction rates must be dramatically reduced (Wackernagel and Rees, 1996). However, current accounting practises often describe as successes those instances where the resource base is being depleted (Schumacher, 1973; Daly, 1992b; Repetto, 1992). This study will therefore examine the thesis that a societal commitment to sustainability and consistent application of the definition of income implies that economic analysis of renewable resource extraction regimes should account for the depletion of stocks of natural capital.

In the short term, capital, labour, government and societies as a whole each receive benefits from the liquidation of renewable resources (Demirovic, 1994). Liquidation may temporarily create high levels of economic activity by providing jobs in extractive and processing industries, government revenue and corporate profits. This allows economies from the local to the international scale to be artificially stimulated, to generate higher levels of material wealth over the short term than can be maintained over the long term. Societies become organized around such abundance. Indeed, as historian Walter Prescott Webb has observed, "Economic systems, political systems, social systems--in short, the present superstructure of Western Civilization--are today founded on boom conditions" (Webb, 1964:14).

Commentators list many ways in which unsustainable extraction levels create dependencies that inhibit addressing ecological limits. Artificially-induced abundance lets people get used to, and expect, ecologically unrealistic levels of material wealth (Schumacher, 1973:26). By providing tangible short-term benefits the industrial economy diverts attention from the ever-increasing ecological liabilities that such an economy creates, such as destroyed salmon streams, depleted soil, and long-term climate change, and the social consequences of such environmental change. Government expenditures necessary to meet the extensive obligations of an industrial state come to rely on revenues generated in an economy with continued high rates, or even accelerating rates, of resource extraction and utilization. Similarly, by virtue of their dependence on profits, corporations evolve in such a way that most can only exist on high rates of throughput and by externalizing social costs (Kapp, 1971:112). Individuals, families and communities become addicted to unsustainable government and corporate activity (Brandt, 1995:Part II). At the same time, the industrial economy leads to increasing inequality (Statistics Canada, 1997), creating pressures for further economic growth and hence resource extraction, ostensibly to improve the lot of those segments of society on the lower rungs of the economic ladder (Daly, 1992b:103-104).

In Canada and BC, much of society benefits from maintaining the artificial abundance provided by high extraction rates as long as possible, though interests directly dependent on renewable resource extraction, such as timber companies and loggers, have a greater stake. Timber companies and unions have stressed the contribution of the timber industry to government revenues. For instance, a Forest Alliance publication claims: "For the average BC taxpayer, the most meaningful measure of the forest industry's economic impact may be its contribution to provincial government revenues... No other single industry or economic sector provides for such a large portion of provincial spending" (Forest Alliance, 1994).

The above overview suggests the central conclusion that the transition to sustainable rates and methods of renewable resource extraction will be very difficult to achieve. The state, capital, labour and society as a whole are each dependent on the short-term benefits from the unsustainable liquidation and utilization of renewable resources. Within the forestry sector, industry, labour and the state frequently point out the dependency of the economy on high rates of timber harvesting. For instance, economic analysis of various land use and resource extraction regimes in BC is used to document the significant social and economic hardships that will result if environmental constraints are imposed on the timber industry (e.g. Resource System Management International, 1994; G.E. Bridges, 1994; Price Waterhouse, 1995).

Despite the dependence of different sectors on high rates of resource extraction, there are segments of society that now believe that the costs of unsustainable extraction of renewable resources are increasingly unacceptable, and that society would benefit from an ecologically sustainable economy. As the accessible stands of timber are depleted, and timber companies seek out timber on steep mountain slopes, in slower growing northern forests, or in community watersheds, the social and ecological costs of industrial forestry mount. Ecological deterioration becomes more serious and widespread, more people are affected, and livelihoods are destroyed. Once resource depletion becomes a reality, communities discover the temporary nature of wealth derived from high throughput of natural resources. It has become increasingly clear that extraction oriented towards the interests of multinational corporations produces few local benefits and often inhibits the diversification of local economies (Power, 1996). In regions where economies have diversified away from dependence on resource extraction, the interests of communities are no longer equated directly with the ability to extract large volumes of resources. There is growing concern that industrial economies are causing unprecedented ecological collapse.

As a colony, British North America was organized largely so as to facilitate the use of crown resources by private interests organized for export-oriented production of primary goods (Innis, 1930). The federal and provincial governments in Canada have evolved over time, but political economists argue that both levels of government continue to be organized in a way which stresses that economic development is to be achieved through the full utilization of crown resources by private corporate interests (Burda et al., 1997; M'Gonigle 1997, 1986; Wilson, 1986). Provincial governments have responsibility for the management of natural resources (excepting the marine and salmonid fisheries), and for collecting resource rents. Responsibility for habitat and environmental protection is contested.

Provinces in Canada appear to have three main reasons for a reluctance to confront corporate interests and require the transition to ecosystem-based management of renewable resources. The first reason is based on a combination of scientific uncertainty, ignorance and ideology, where it is felt that aside from minor adjustments, current resource extraction arrangements are both proper and sustainable, and therefore no confrontation is necessary. However, the evidence increasingly conflicts with this position. The second reflects the mutual dependence between government and industry, and the long history of provincial governments as agents facilitating private utilization of crown resources, to the detriment of local control over resource exploitation (O'Connor, 1994:140). The third is the political need for government to be seen as promoting the interests of resource-dependent communities, which reflects the dependence of government on organized labour. Thus, in BC, maximum sustained yield policies were based on the belief that sustained timber flows would stabilize employment and income in forest dependent communities (Haley and Luckert, 1996:58).

The end result of this reluctance to require a transition toward sustainable resource extraction is that government delays taking the required measures to protect the renewable resource base until it is too late and there is no option (Ludwig et al., 1993). This is particularly true when there exist high levels of uncertainty about future resource levels, yet managers do not adopt a precautionary stance (Ruitenbeek, 1996b:105).

A dramatic example of this failure to act at the federal level was seen in the case of the collapse of the North Atlantic Cod fishery, despite repeated warnings by both scientists and fishers that the resource was in trouble. The state is thus in an apparent bind. If it attempts to lead society forward in the transition to lower levels of extraction, thereby forcing itself and other economic players to adapt, it will face political fallout as adaptation reduces benefits to vested interests and to society generally. If it allows continued over-exploitation, it makes inevitable the day of reckoning when accumulated ecological damage and the collapse of the renewable resource base will leave both the state and the society it represents in serious economic and ecological difficulty.

1.2 Can Economic Analysis Contribute to Sustainable Management of Renewable Resources?

Economic analysis has been used extensively in BC, especially within the last decade, to support decision-making where different timber extraction and land use regimes are being considered. Numerous actors, including industry organizations such as the Forest Alliance, have suggested that economic analysis can help to make such decisions more rational. Even advocates of a more ecological agenda have suggested that more extensive use of economic analysis to support forest management decisions would advance the preservationist or ecoforestry agenda because such analysis would make it clear that industrial forestry often results in a net economic loss to society (M'Gonigle et al., 1992; Hammond, 1991:246). This position can be seen as part of a broader phenomenon, where economists with sincere concerns about humanity's environmental predicament argue that, by putting a price tag on nature, society would implement policies better able to protect ecosystem services (see Daily, 1997, Costanza et al., 1997).

The province of BC has issued guidelines for economic analysis of forest land use decisions, requiring that the analysis follow a multiple accounts analysis framework (Province of BC, 1992). This technique is intended to provide documentation of the economic, social and environmental effects of various courses of action, such that the full spectrum of tradeoffs between alternative courses of action can be appreciated (Gunton et al., 1991). Many studies have been carried out under these guidelines. Yet signs of social conflict as a result of forestry land use and extraction regime decisions show no signs of abating (M'Gonigle, 1997), and the rate of resource extraction has not greatly diminished (Sierra Legal Defense Fund, 1996b).

As this study will explore, one reason for the possible failure of economic analysis to reduce social conflict and to favour lower rates of resource extraction is that the analysis is carried out in a way that is in many respects inconsistent with the economist's definition of income. Economists have long held that, in determining how much income a given economic activity generates, it should be calculated from the starting point that capital used in production is to be maintained intact. This proposition is definitional, but it also serves two pragmatic purposes. The first is to provide standards of honest reporting, such that users of economic analysis or accountant's reports are not misled as to the value-added generated by a given activity. The second arises from the need, first felt by merchants, to be able to differentiate between income and capital, such that merchants or entrepreneurs would know how much they could consume without endangering future personal and commercial well-being.

Economic analysis designed to compare future streams of benefits of alternative resource extraction regimes should, if it is to be consistent with this understanding of income, accurately report what proportion of the benefits can be enjoyed while maintaining capital intact. As will be seen in chapter 3 of this study, economists have re-examined Sir John Hicks' definition of income in the context of a world pressing against ecological limits. Hicks' definition, it is argued, implicitly builds in the concept of sustainability. For the purposes of income determination, capital is to be maintained intact--the problem is that economists have applied Hicks' definition to manufactured capital only. This raises the question of substitutability between natural and manufactured capital. If there is critical, non-substitutable natural capital--an empirical question that must be considered in the context of prospects for substitutability and technical progress--then it is imprudent behaviour to deplete natural capital in a such a way that future income is unacceptably reduced. With non-substitutable capital, in a world close to ecological limits, the economist's perspective strongly suggests that natural capital should be maintained intact if society desires sustained income.

Questions of the appropriate level at which natural capital stocks should be maintained can also be approached from the perspective of recent societal expressions of commitment to the concept of sustainable development. Governments have been forced into such commitments as a result of considerable public pressure to do something about the environment. While it is clear that current practice and environmentally-related governmental policies and initiatives are inconsistent with sustainable development, the declared commitment to the principle of sustainable development remains. If a society decides that it wishes to be fair to future generations and to provide them with the ability to meet their needs and to keep their options open, then it is necessary to go beyond market criteria and determine what social ground rules apply to one generation's legacy of natural capital stocks to the next (Dobell, 1992:4). If some forms of natural capital are essential to the provision of certain ecological services and/or the production of goods and services to meet given needs, and if much natural capital depletion is irreversible, then in a world close to ecological limits, the only way to ensure fairness to future generations is to preserve stocks of natural capital intact. Economists should therefore adopt sustainability as an objective that their analysis can help to achieve, much as they currently assume that the achievement of economic efficiency is a desirable policy objective.

However, as this study will document, the economic analysis required by provincial guidelines and past studies carried out in accordance with these guidelines have not incorporated the requirement that natural capital should be maintained intact. To the contrary, the guidelines set out a methodology which discriminates against strongly sustainable renewable resource extraction regimes by requiring that scenarios projecting the continuation of the status quo be used as baselines for economic analysis. Yet frequently there is evidence that the status quo is not a viable trajectory: while policies and practices may remain unchanged, forests are unlikely to be able to produce the level of output projected in the analysis, due to resultant environmental degradation, overly optimistic assumptions, and the increasing brittleness[1] of managed forests.

Furthermore, at present the provincial government has an inadequate picture of the economics of industrial forestry. It sees the revenue, but it does not account for changes in the value of the crown's forest assets brought about by industrial forestry. If a business were managed on the basis of the revenue flow, without regard to the value of its assets, it could appear to be doing very well when in fact it is merely selling all its inventory and heading down the path to bankruptcy. Just as a firm may, for a short period, choose to ignore the depreciation of its capital investment in order to maintain artificially high levels of revenue, the province may ignore the depreciation of its natural capital in order to collect temporarily high levels of revenue, and to enjoy other benefits. However, the province (and its citizens) should be aware that it is allowing natural capital to be depleted, it should separate out the portion of revenue that is true income from that portion of revenue which represents depreciation of natural capital, and it should take these facts into account in its economic and revenue projections (Repetto, 1992:98). The costs to the province of managing and encouraging industrial forestry are substantial, requiring a larger amount in government subsidies and tax breaks than the taxes and resource rents the government collects from the timber sector (Mascall, 1997). The industrial forest economy increases the indirect costs of ecological deterioration such as the need for defensive expenditures.

[1] Holling (1994) uses the term "brittle" to describe managed ecosystems that can no longer absorb a given disturbance without flipping into a persistently degraded state because management efforts to control a target ecological variable (such as insect levels, fire, timber outputs, etc.) have led to homogeneous landscapes, the loss of redundancy, and the loss of structure and function. (See also Holling, 1992, 1986; Burton et al., 1992:232.)

Industrial forestry also forecloses on options for other economic activities; the province faces the opportunity cost of losing revenue from businesses which cannot profitably operate in a landscape modified by industrial forestry.

A related shortcoming of current economic analysis appears to arise from ecologically deficient metaphors for renewable resource stewardship. Maintenance of natural capital--or, in more common usage, the equivalent dictum "living off the interest"--has in the past been interpreted simplistically. So long as less than the annual increment of growth in a renewable resource was harvested, it was held that one's use of nature was responsible. Thus, the conversion of wild forests to plantations managed for sustainable yield on the basis of scientific forestry (the so-called normal forest) was seen as entirely consistent with living off the interest. Yet this perspective focuses on the forest as a narrowly defined capital stock providing simple flows of timber, rather than an integrated and interdependent form of natural capital that provides a diverse set of ecological services as well as a flow of marketable commodities.

By referring to forest ecology, landscape ecology, and conservation biology, it becomes clear that modern plantation forestry does not maintain the natural capital of the forest intact. To maintain a forest's integrity requires that the forest be managed at the landscape level through some form of ecosystem-based planning, and that the managed forest not contrast significantly with natural forests. The managed forest must therefore contain the same structures and legacies as a natural forest, provide for the continuation of existing ecological processes and functions, and provide for similar genetic, species and habitat diversity.

To sum up, the problems that motivate this research study are as follows. Shortcomings in economic analysis currently conducted in BC, compounded by the lasting influence of simplistic understandings and rules of resource stewardship, have the potential to significantly undermine the selection of more strongly sustainable options in favour of options which involve the liquidation of natural capital stocks. The results of such analysis purportedly have a major influence on which alternatives are seen as desirable and what courses of action are ultimately chosen. Because these decisions affect such a large portion of BC's landbase and ecosystems, as well as human communities, both the future of the forest sector, and society's capacity to put itself on a sustainable footing, are at stake. The failure to take into account the depletion of natural capital stocks may lead to decisions that involve serious and irreversible consequences.

1.3 Research Question and Thesis of this Study

In response to the above controversy, the thesis of this study is that the economic analysis of renewable resource extraction and land use regimes should account for natural capital depletion. Accordingly, this study reviews the literature on accounting for natural capital. Many proposals have been made for adjusting the national accounts to take into consideration the depreciation of natural capital, but each has its own set of problems. Proposals for accounting for natural capital depletion in project appraisal have also been advanced; but no satisfactory answer has been identified. The pragmatic resolution proposed in this study is that the benefits from a given renewable resource extraction regime should be divided between those benefits which could be obtained if resource extraction maintained natural capital intact, and those benefits which are based on depletion. To make such a division, the analyst needs first to know what stream of benefits could be obtained from a renewable resource extraction and land use regime in which natural capital is maintained intact. Such a determination raises a host of scientific questions, and depends on the model that one uses and on the availability of detailed data concerning the "capital stock" of the forest. Defining such a sustainable baseline is a difficult task, but it must be attempted nonetheless. (The tool proposed in this study to make such a determination involves the use of ecosystem-based planning, in which large landscapes are zoned to protect landscape-level processes and functioning according to the findings of conservation biology and landscape ecology. Forest ecology is used to determine stand-level extraction methods and levels consistent with maintaining stand structure and function.)

In the BC context, economic analysis of renewable resource extraction regimes is usually carried out in a multiple accounts framework; this study accordingly also examines, though more briefly, how the multiple accounts framework should be modified to better address the state of natural capital stocks, and to better model ecosystem-economy linkages. In addition, the multiple accounts framework needs to be modified so that the environment is no longer taken merely as an amenity which provides recreational, existence and other such benefits. Rather, ecological integrity is seen as essential to economic activity, and the economy must be constrained so that it respects ecological limits. Furthermore, the baseline scenario for analysis should not be status quo extraction levels and methods, but rather a scenario consistent with maintaining natural capital intact.

If the above thesis is correct, economic analysis currently conducted according to BC Ministry of Forests guidelines is lagging behind best practice and fails to reflect long established economic conventions. By making the appropriate corrections, the proposed modifications would shift the policy focus that results from consulting economic studies of forest use decisions, from avoiding the economic hardships entailed by transition, to seeking the best means of making the required transition. As a consequence, industrial forestry would no longer appear so desirable or inevitable.

1.4 Economic Analysis, Perspective and Politics

Despite the apparent promise offered by such modifications to incorporate the imperative to maintain natural capital intact, there are compounding factors, namely, the political economy within which such analysis operates, which could either diminish or increase the import of these modifications. There is therefore an important context to this research study. In carrying out this work, I decided to use a case study approach, focusing on the Slocan Valley of southern BC.

The Slocan Valley has been selected for a number of reasons. There is widely held concern among Valley residents that continued industrial forestry will cause serious ecological deterioration and damage to other sectors of the economy. The Silva Forest Foundation has prepared an ecosystem-based land use plan for the Valley; one of the key purposes of this plan is to determine what level and method of timber extraction cutting is consistent with maintaining ecosystem functioning over the very long term (Hammond et al., 1996). This plan has a broad base of support (Angus Reid, 1996). The Valley economy has diversified over the years, and now supports significant retirement, value-added, home-based and tourism industries, all of which depend on environmental quality for their vitality. The informal economy appears to be strong. Because of past community resistance to timber cutting in watersheds and on steep valley walls, the Valley ecosystem is relatively intact, and despite the need for ecological restoration, it is not too late to implement an ecosystem-based land use plan. The Ministry of Forests and the timber industry still resist any such approach. In a letter from the Minister of Forests to the Silva Forest Foundation commenting on the proposed plan, the Minister rejects the plan because it would cause "drastic reduction in tax revenues from timber sales" and "the plan requires more financial support than could be generated by economic activity in the community" (Zirnhelt, 1996).

The complex biophysical, political, social and economic conditions in the Slocan Valley make up an ideal acid-test of the theoretical issues that arise when economic analysis is called upon as an instrumental tool for sustainable development, and of the practicality of proposals advanced in this study. This case study helps expose the theoretical and practical limitations of methods proposed in the literature to account for the depletion of natural capital. The Slocan Valley case study also allows me to explore the political economy of modifying economic analysis to incorporate the need to maintain natural capital intact.

Three chapters focus on the Slocan Valley. Of these, Chapters 2 and 7 are written from my personal perspective, based on a year living in the Valley and in nearby Nelson, observing and participating in the conflict over the future of the Valley's forests. These two chapters are unusual in that they are written in a personal voice, and attempt to paint a richer portrait of the dilemmas and struggles faced by the residents of the Slocan Valley. For instance, they make clear that vested interests have a strong incentive to preserve the status quo, while those who advocate change are marginalized by the mainstream and often alienate the mainstream through the alternative lifestyles of some of their number. Chapters 2 and 7 are therefore somewhat similar to participant-observer studies once common in anthropology. I also adopt such an approach because of my appreciation for the way in which early political economists, and more recent scholars such as Karl Polanyi and E.F. Schumacher, have drawn extensively on observations on the economic world of day to day life. Chapters 2 and 7 ultimately raise doubts over the potential contribution that economic analysis, reformed so as be consistent with an interpretation of the concept of income appropriate for a "full" world (whereby income is obtained in a way that maintains natural capital intact), can make to reduce conflict and to encourage sustainable outcomes.

Chapter 2 sets the context for examining arguments suggesting that economic analysis can help reduce conflict in land use and resource extraction decisions, by illustrating that there are at least three very different economic perspectives from which such decisions are seen. Valley residents who are advocates of strongly sustainable extraction regimes within the Valley are, when viewed through the economist's lens, concerned with maintaining a diverse bundle of natural capital stocks and the many flows and ecological services that such stocks of natural capital provide. The major forestry corporation in the Valley, beholden to distant shareholders and operating under the influence of market pressures, is concerned with maximizing the value of its rights to extract timber. Those Valley residents who are dependent on the continued profitability of the corporate tenure holder have conflicting interests in maintaining natural capital intact to enjoy the benefits it provides to residents, and encouraging its liquidation to benefit from wages directly and indirectly provided by the forest industry. The economic analyst, by adopting a given methodology and perspective, inevitably privileges one perspective, and one set of values to the detriment of opposing perspectives and values. The underlying conflict remains unaddressed.

Chapter 7 further complements this point by documenting how the decision-making process is currently unable to accommodate divergent values, scientific uncertainty, and conflicting interests. The hopes of promoters of economic analysis as a means to reduce conflict and to arrive at rational decisions appear to be based on a poor characterization of the problem. Forest land use and resource extraction choices are not well characterized as a scientific problem requiring an analytical solution. Rather, the problem is philosophical, ethical, and scientific; it involves contested definitions, interpretations, and understandings. The solution needs to be a consultative, consensus seeking, shared decision-making process. Post-normal science[2] can contribute to such decision-making by providing analysis of the implications of various decisions in a framework where values are explicitly stated, uncertainty acknowledged, an interdisciplinary stance adopted, and diverse viewpoints and interests considered.

1.5 An Ecological Economics Theoretical Perspective

This study will draw extensively on the ecological economics literature. Ecological economics has been described as a transdisciplinary field of study, drawing on both economics and ecology to synthesize new intellectual tools and models which are focussed on solving the problems faced by humanity as human use of the biosphere breaches ecological limits. The human economy is seen as a subset of the larger biosphere (Costanza et al., 1991:3). Economic activity involves a one-way entropic throughput of energy and materials, where useful forms of energy and materials are used, and transformed into unusable waste products. Economic activity is thus constrained by the first and second laws of thermodynamics (Georgescu-Roegen, 1971). Finite sources of energy and materials are run down and finite sinks fill up, and though the input of solar energy does allow for a certain amount of recycling, if we consume beyond this rate it is at the expense of future generations (Daly, 1992b:206-207). This study will go beyond an ecological economics approach to draw inspiration from the even more recent school of socio-ecological economics. This latter school focuses on the cultural and ethical values, institutional and political structures and processes, and power relations which influence the physical transformation of matter and energy (Jacobs, 1996:14). When socio-ecological economists seek to influence policy, their commitments generally include: sustainability; the

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[2] Post-normal science, unlike normal science, does not pretend to be value-free or ethically neutral. Instead, the methodological, societal, and ethical issues raised by scientific inquiry and practise are openly considered by post-normal scientists. Research occurs in a context where facts are uncertain, values in dispute, the stakes are high and the need for decision is urgent. (See Funtowicz and Ravetz, 1991.)

just redistribution of income; the just redistribution of power; participatory democracy, including economic democracy; elimination of gender-based economic and power inequities; and a conception of human well-being that goes beyond utility maximization through consumption (Jacobs, 1996:15).

While neither ecological economics nor socio-ecological economics has yet achieved mainstream acceptance, the increasing frequency with which articles from Ecological Economics are cited suggests that the effort to bridge the economics/ecology gap has gained a healthy degree of respect amongst academics involved in sustainability debates (Costanza, 1996).

The transdisciplinary nature of this study, and in the ecological economics endeavour generally, has led to my involvement in a complex web of theories, theories which, if they are not pulling in opposing directions, tend, at best, to fit poorly together. In undertaking this study, it seemed that each time I tried to anchor one segment of this theoretical web, tensions readjusted all other anchor points. Each of these anchor points then needed revisiting to see if it still held. At times, a strand of thought or the implication of a given theory or of empirical data has had to be left only cursorily examined, only partially anchored--otherwise this research could never be completed. This may leave individual readers, coming from a given specialty, to feel that their subject is inadequately covered off or perhaps inaccurately characterized. The ecologist may have reservations about the discussion of ecological integrity, the economist may feel that controversies in capital theory are inadequately addressed, while Ministry of Forests personnel may feel that some data have been misinterpreted. In none of the individual subject areas touched on here, from political economy to landscape ecology, can I claim to be an expert. Yet my focus is on the synthesis of these diverse subjects in order to address, in a pragmatic manner, urgent questions concerning the appropriate way to conduct economic analysis of renewable resource exploitation. Past efforts by economists to broach economic analysis of renewable resource exploitation have, from my perspective, proven woefully inadequate to the task of usefully contributing to better land and resource stewardship. Where readers trip over relatively minor flaws in this study, I urge them to focus on the larger argument contained in these pages. I make no pretense of providing a final answer to the difficult questions posed. Rather, I seek to challenge and to enrich the approaches to economic analysis currently used in BC, as they are currently very poorly suited to the task of guiding society to outcomes which respect ecological limits *and* provide for human well-being, especially if our time frame of concern is to reflect the interests of the children and grandchildren of the current generation.

1.6 Organization of this Study

Chapter 2 provides the setting for the case study. In the Slocan Valley, there are three contesting perspectives. A significant portion of the community views itself as grounded in Valley ecosystems, and is concerned about the whole bundle of flows, services and natural capital stocks in the Valley. The timber corporation is interested in natural capital viewed narrowly. Another part of the community identifies its interests with the continued viability of the timber industry.

Chapter 3 provides a review of why up-to-date definitions of income and income accounting techniques are expanding beyond the exclusive focus on manufactured capital to consider the natural capital stock and its potential to provide ecosystem services and to support economic activity. The assertion that the stock of natural capital should be maintained is based on three key arguments or propositions that are themselves contestable:

- there are critical, non-substitutable stocks of natural capital;

- society wishes to assure non-decreasing income into the future; and
- society wishes to ensure that future generations will be able to meet their needs and will have the option to enjoy the ecological services and flows provided by natural capital, similar to those enjoyed by the current generation.

The economist and the accountant therefore need to know, for income determination purposes, whether the natural capital stock is being maintained intact. The chapter then moves on to consider what maintaining natural capital intact implies from an ecological perspective.

In Chapter 4, the province's guidelines for economic analysis of land use and resource extraction alternatives are reviewed, as are past studies in which the guidelines have been applied. The guidelines specify that economic analysis is to occur in a multiple accounts analysis framework, such that environmental and social impacts are considered in parallel accounts. This review is intended to determine, first, whether provincial management regimes assessed under the guidelines involve natural capital depletion, and secondly, how economic analysis conducted according to provincial guidelines deals with streams of benefits derived from natural capital depletion.

Chapter 5 (and Appendix 1) make clear the intractable difficulties of measuring natural capital depletion and of taking natural capital depletion into account in any economic analysis. Because of these difficulties, this study proposes a pragmatic approach to adjusting for natural capital depletion and to making multiple accounts analysis more useful as a tool that incorporates a sustainability objective.

When the modifications proposed in Chapter 5 are applied to the Slocan Valley case study in Chapter 6, it becomes evident that the analyst has no clear baseline from which to conduct the analysis. Even though it is difficult to dispute that current forestry extraction and land use regimes are unsustainable, defining a sustainable path involves contested terrain, uncertainty, questions of values, and different interpretations of responsibility. However, the proposed changes do reframe the debate towards those issues that should be debated, considered and resolved if sustainable development is indeed to be a societal objective, or if maintenance of natural capital is to be equated with prudent economic behaviour.

As noted previously, Chapter 7 shows that, in the context of sharply divided values, the decision process currently lacks an effective advocate for sustainability. This despite a growing proportion of the population who seek reform, often at the cost of great personal hardship, and the existence of a broader social and ethical interest in sustainability. Chapter 8 concludes that the Ministry of Forests is behind in its science and in its application of economic analysis, that it has been captured by industry, and that its reporting methods and decision-making processes fail both the provincial and public interest. Society deserves better information, reporting and decision processes. Unfortunately, without significant changes to the current distribution of political-economic power, such reform is unlikely to be forthcoming.

Chapter 2: The Slocan Valley as a Case Study

2.1 Chapter Overview

This chapter introduces the Slocan Valley Case Study, including my first impressions of the Valley and the reasons for selecting it as a case study, a brief biophysical description, and selected moments in the history of logging and conflict in the Valley. In this chapter, I set out my values and perspective, stopping first to explain why it is appropriate for economists to do so, and why economic analysis is inherently value-laden. This chapter thereby clarifies the complicated biophysical, social, political, and value context within which economic analysis takes place in BC, and reflects on the role of economic studies in political decision-making. These issues are further developed in Chapter 7.

2.2 Why Set out One's Values and Perspective

Economists often portray themselves as objective commentators, much like weather forecasters. There is no point in being mad at a weather forecaster because she has predicted bad weather--she just tells you what appears on her radar screen. In a similar vein, economic analysis has been offered as a way of contributing to more rational forest extraction and land use decisions. It is offered as an objective means to analyze the economic consequences of alternative courses of action, and to help identify alternatives that are the most efficient.

However, a long tradition disputes claims by economists to objectivity. Economist and historian Karl Polanyi, for one, insisted that research in the social sciences is always carried out from a particular viewpoint, that it relies on concepts which have value implications, that it seeks to answer certain questions and not others, and that it may have the effect of prolonging the status quo, or, more rarely, of contributing to change (Baum, 1996:37). Economist and Nobel laureate Gunnar Myrdal came to a similar conclusion. For Myrdal, to purport to judge policies "from a 'purely economic point of view' is thoroughly metaphysical" (Myrdal, 1990[1954]:195). To guard against the hidden moral and political element contained in any economic analysis, early in his career Myrdal suggested that economists should explicitly state their values at the outset of the analysis. By the end of his life, Myrdal went much further, entirely abandoning the quest for an objective economics. He concluded that the pseudo-objectivity of neoclassical economics should be discarded, and economics should return to its original status as a moral science (Sweedberg, 1990:xxvi-xxix). Max Weber also held that economic analysis could never be neutral. The replacement of political debate and decision-making with economic evaluation excludes the values underlying economic theory and prescriptions from debate. This can lead to outcomes where reality grows increasingly to resemble the dismal theory used to interpret and guide society's decisions (Deblonde and van der Straaten, 1996:17).

I myself am persuaded that economic analysis is inherently imbued with values, a view which seems to be gaining the upper hand (see Hausman and McPherson, 1996). Therefore, in this chapter and in Chapter 7, I set out the situation as I see it in the Slocan Valley, and in doing so, I make my values more transparent. In one sense, this may prove to be a poor tactical move. It will allow critics of the present study to accuse me of lacking objectivity, of holding a bias towards the environment, or against the existing forest industry and the institutions which perpetuate it. Some critics might therefore reject this study and its findings out of hand.

Yet to omit the present and the second-to-last chapters would be to proceed with the study in a way which would involve several shortcomings. First, I would be hiding behind the same false veil of objectivity that I decry in others. More importantly, the inclusion of Chapters 2 and 7 allows me to explore, albeit tentatively, the role that economic analysis actually plays in policy debates and decision-making. These chapters will contrast with reports providing detailed economic analyses of various futures for the province's forests. It is my hope that these two chapters will convey to the reader how, behind tables of jobs per 1000 cubic metres of timber, thousands of dollars of income or revenue, and behind dispassionate descriptions of widespread landscape modification in the environmental accounts, there is both an ecological and a social landscape that is being profoundly affected by current economic arrangements. These chapters will show that there are three very different perspectives at play in the Slocan Valley, and that analysis cannot bridge the gap between these perspectives, and hence, that the ability of analysis to resolve conflict is severely limited. By adopting a given perspective, economic analysis can favour one segment of society at the expense of others, and favour a given policy direction.

Finally, economics as we now know it evolved out of a richer field of inquiry known as political economy, and, still earlier, moral philosophy. The early economists immersed themselves in the political and economic problems (as they saw them) of the period of which they were a part. Questions of power were part and parcel of the inquiry. In contrast, recent economic thought has been characterized as attaining "a degree of unreality that can be matched only by medieval scholasticism" (Heilbroner and Milberg, 1995:4). By proceeding as if economic inquiry can exist as a socially disembodied study, economics sets itself up for an "extraordinary combination of arrogance and innocence" in its approach to contemporary problems (Heilbroner and Milberg, 1995:6). While ecological economists have sought to bridge economics with ecology, they too have for the most part kept power out of the equation (Gale, 1996).

To their credit, ecological economists such as Daly have repeatedly called for recurrence to the concrete in search of inspiration, to avoid the fallacy of misplaced concreteness.[3] The Slocan Valley is my search for the concrete. It helps clarify the practical as well as the conceptual difficulties involved in accounting for the depletion of natural capital, and forces me to come up with proposals which could actually be applied. It also helps to explore the extent to which reformulating economic analysis to take natural capital depletion into account can realistically contribute to long term ecological health and social well-being. when many institutions and vested interests benefit by prolonging the status quo, and there are many incentives to avoid change.

The "confession" of certain values and perspectives in this chapter and in chapter seven has another salutary effect. Aware that any critics will know my starting point, I have sought cautiously to support my position carefully in the theoretical portions of the study. Chapters 3 to 6 are accordingly written in the more traditional voice of the dispassionate observer, relying on the authority of many scholars to buttress each significant position. In the end, this confession has mainly come about because of my despair at society's seeming inability to respect ecological limits. I see the web of life unraveling before me. While I hold the influence of neoclassical ideas largely responsible for justifying an economic system that leads to such tragedy (see Green, 1997; Deblonde and van de Straaten, 1996), I often despair that new ecological economic theory, being so fundamentally at odds with the status quo, will be unable to contribute in a significant way to change in the little time left before an era of ecological calamity is upon us.

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[3] Daly argues that misplaced concreteness is the "cardinal sin of standard economics" (Daly, 1992b:285). It can be defined as "trying to answer a question pertinent to one level or degree of abstraction with concepts relevant to a different level or degree of abstraction" (Daly, 1992b:196). It often occurs when one neglects the degree of abstraction involved in theoretical analysis and when one thereby draws conclusions from the analysis which overstep the limits that were necessarily imposed in order to make the initial abstractions. Thus, there is a danger of committing this fallacy if one defines the conditions under which maintenance of forest capital takes place without reference to an actual forested landscape to see if the abstractions were judicious and if the resulting analysis makes sense.

2.3 First Impressions of the Slocan Valley

In my first summer visit to the Slocan Valley, in the summer of 1993, I was immediately hooked. The Slocan Valley is undeniably beautiful, offering a broad palette to the eyes, from the pastoral tranquillity along the edges of the Slocan River to the glacier-capped peaks of the Valhallas. It still enjoys an ecological vitality that is becoming increasingly rare. This vitality allowed me to scoop drinking water straight out of the creeks that tumble down the steep and narrow drainages along the valley's edge. The valley inspires a sense of belonging that struck me: people's identity was as Slocan Valley residents. Social networks that reached up and down the valley were impressive in their vigor. Many people appeared to be actively questioning a materialistic society, and to be seeking livelihoods that were sustainable.

In the Slocan Valley, there is a tradition of dissent from mainstream culture. The Doukhobors, a pacifist religious sect originally from Russia who settled in the area in their quest for religious and cultural freedom, were early dissidents. The Doukhobors split into three factions, the first two of which sought to integrate with mainstream society, while maintaining their religious practices. The third faction, the Suobodniki or "Sons of Freedom", inspired by their religious beliefs concerning fire as a form of cleansing, resorted to arson, bombings, and displays of nudity as forms of protest. Their protests were in response to materialism within their own community, and to the fact that they felt betrayed by the Canadian government. The Suobodniki believed they had been promised 99 years of total religious freedom, including exemption from taxation or public education. The state reacted by forcibly removing their children and placing them in a residential school; the school was formerly New Denver's Japanese internment camp. Such protests have grown more moderate and infrequent, but they still continue to this day. In the late

60s and early 70s, a new wave of immigrants, many of them urban refugees or Americans seeking a less militaristic country, settled in the valley. There was a large amount of experimentation, ranging from a community-initiated alternative school, to a cooperative burial society. With the 1984 discovery of a Sinixt burial ground at the confluence of the Little Slocan and Slocan rivers, the Sinixt, who in the past century had been forced to live in the portion of their territory south of the international border, sought to ensure respect for their ancestors and to re-establish a presence in the Slocan Valley (Wagner, 1997). There is a strong sense of commitment, which I first felt when I observed a meeting of the Slocan Valley Watershed Alliance, and learned of how long they had been working to protect their watersheds. Still, it would be misleading to leave the impression that the valley is not without its own factions and discord. While an increasingly sizable minority seek to put society on a more sustainable footing, much of the Valley population appears to accept the status quo.

It was because of Herb Hammond, a forest ecologist and professional forester, that I had crossed the country to visit the Slocan Valley. I had found out about Herb while I was working for the Innu Nation in Labrador to forestall plans for large scale industrial forestry in the Innu traditional territory. Finding a professional forester with a good knowledge of forest ecology, who would appreciate the imperative for the Innu people to maintain the integrity of their traditional territory and its ability to support a traditional lifestyle, had not been easy. Someone was needed who would critically review government and industry forest plans, identify gaps in ecological knowledge, and propose a holistic alternative. There were few candidates, and so it was that Herb came out to Labrador to work with the newly assembled Innu forestry team. We tramped through Innu forests battling blackflies, taking measurements, digging soil pits, and learning from Innu experts. At a later date, Herb, the director of Innu Rights and the Environment, two forest company officials, and I spent a week touring various industrial and alternative forestry operations in BC.

In order to learn more about forestry issues, I ended up as a guest of the Hammonds, spending a week discussing forestry issues at their home and office. At the Silva[4] office, Herb would frequently interrupt his work to pass on news of the latest travesty against BC's forests. Calls would come in from around the province, from landowners and small communities upset over logging plans, to First Nations involved in disputes with the Ministry of Forests, to environmental activists scrambling to protect some unique valley. A few days of listening in on such calls would provide ample evidence that the BC forest industry is causing extensive social distress and ecological damage. No request for assistance seemed to be turned down, and often it wasn't until well into the evening that we piled back into the truck for the trip back to the Hammonds' home. There was also a sense of intellectual stimulation at the office, as Silva employees worked not only to critique existing forest plans, but to work with First Nations and communities to come up with alternatives grounded in forest ecology, landscape ecology, conservation biology, and indigenous ecological knowledge. Scientific articles circulated around the office. Maps generated by using a Geographic Information System set out Silva's interpretation of how ecological theory could be applied through a system of ecosystem-based zoning, to protect the landscape's integrity, while still allowing for timber extraction, though at much reduced, sustainable levels.

Reading through the impressive collection of articles, books, and studies in the Silva library, it became clear to me that industrial forestry would fundamentally alter the Labrador landscape in a way that would be very detrimental to Innu interests. Often, though, what Herb proposed was so fundamentally opposed to the status quo that I would become skeptical. I would ask myself if the reduction in cut that an ecosystem-based approach

[4] The Hammonds have founded two organizations that share offices. Silva Ecosystem Consultants is a consultancy, while the Silva Forest Foundation (SFF) is a non-profit organization. They are referred to here as Silva when it is not important to distinguish between the two.

would require, then estimated at 75% or more for many BC forests, was truly implied by applying forest ecology, landscape ecology, and conservation biology to forest management. Was there not some way to get more timber out? What would happen to the economy as a result of such a radical reduction in the cut? Surely we did not have to be as ecologically cautious as the Silva studies suggested. Yet at other times the Silva approach made a lot of sense, especially in the context of the forest management plans I was then reviewing in Labrador.

In that first visit, I also failed to appreciate the extent to which the Slocan Valley had already been transformed, first by miners, then by loggers. I hiked into a few of the watersheds, but did not make it up to Tree Farm License 3, the area most extensively logged, or to some of the other more contentious areas. Yet even so, the serenity in the Valley would be interrupted by the sounds of a chip truck echoing off the narrow valley walls. Frog Peak, seen on the way to and from the Silva office, looked like a good destination for a day-long ramble through the bush--except for a marring clearcut close to the peak. It was evident that even the broad base of support for alternatives to clearcut logging in the Slocan Valley was failing to protect the Valley's unique character.

When I decided to pursue a graduate degree, a few years later, it was clear to me that it would involve the Slocan Valley and the ecosystem-based planning approach proposed by Silva. There was a marked contrast between how ecosystem-based planning intuitively appealed to so many individuals and First Nations, yet was simultaneously dismissed as impractical and too radical by government, industry, and timber industry workers. At first, I intended to do an ecological economic critique of the ecosystem-based plan for the Slocan Valley that the Silva Forest Foundation (SFF) was preparing at that time, but for a variety of reasons I decided to ground my thesis in a more conservative application of economic theory. After all, I had decided to study economics once it became clear that the world marched to the economist's drum, or rather, that the economist's drum drowned out any calls for a reassessment of the path much of humanity was taking.

2.4 Biophysical Description of the Slocan Valley

Later chapters of this study will make reference to various land use and forestry scenarios for the Slocan Valley. Because the Slocan Valley is not a separate administrative unit, the Ministry of Forests does not conduct economic or timber supply analysis on the scale of the valley itself. It is therefore necessary to scale data either from the level of the Arrow Forest District or from the still larger region covered by the Kootenay-Boundary Land Use Plan (KBLUP). At the same time, the Silva Forest Foundation has not applied ecosystem-based planning on the scale of either the Arrow Forest District or the Kootenay-Boundary Land Use Plan. The case study will therefore have to flip in scale or focus from the level of the Slocan Valley, to that of the Arrow Forest District, or to that of the KBLUP, depending on which level has appropriate data.

During the Commission on Resources and Environment (CORE) process, land use planning within the Kootenay-Boundary region was carried out by two separate tables, dividing the region into the East Kootenays region and the West Kootenay-Boundary region, the latter of which contains the Slocan Valley. It is therefore simplest to briefly describe the larger region by considering the two subregions separately.

2.4.1 The East Kootenay Region

The East Kootenay region is in the southeastern portion of the province of BC. It is bordered in the east by the continental divide, which is also the border between BC and Alberta, in the south by the US border, and to the west by the height of land along the

Purcell and Northern Selkirk Mountains. It extends north to Kinbasket Lake (see Illustration 1). It is a mountainous region, the mountains being generally gentler in the south, and more rugged to the north, creating a diversity of microclimates. The climate is generally hot and dry in the summer, and cold in the winter, the south eastern portion being the driest and warmest. The East Kootenay region contains within it 11 ecosections, supporting mountain lions, black bear and grizzly, and seven species of ungulates (Owen, 1994a:27-40). As noted in the CORE Land Use Plan,

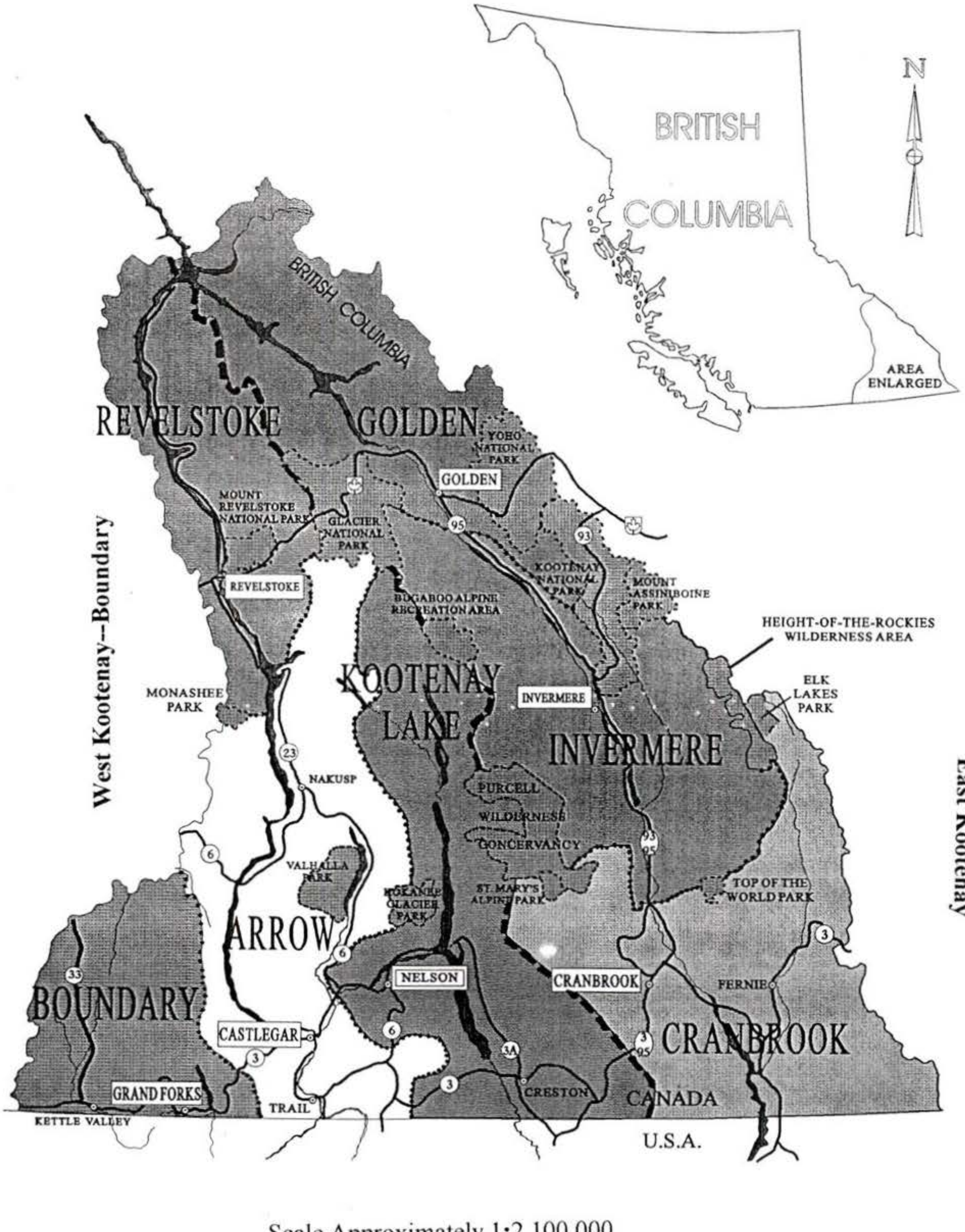
> The vast majority of the province's elk and Rocky Mountain bighorn sheep live in the East Kootenays. No other area in the province has as many species of big game cohabiting common areas, nor has as many Rocky Mountain elk, Rocky Mountain bighorn sheep, white-tailed deer or Wyoming moose. The complement of other species...makes this ecosystem unique in all of North America. Its large mammal predator-prey systems and sizable grizzly populations are of international significance (Owen, 1994a:38).

A long period of apparently prosperous indigenous life in the Kootenay-Boundary region began to be displaced by a large influx of mining prospectors and mine workers in the late nineteenth century. Early prospectors often set forest fires to expose bedrock, significantly altering the ecology of the area, and contributing to the rarity of old growth. Settlement pressures increased, and as the new century dawned, forestry activities became significant. Initially forest operations were directed toward supplying timber for the mines and boom towns, but production eventually became geared toward serving the prairies and US markets.

By the 1940s, the easily accessible stands in the southern portion of the East Kootenay region had been largely logged (Owen, 1994a:31-32). Forestry is now a dominant force in the East Kootenay economy: there are five large lumber mills, and a pulp mill. There are also many small to mid-size operations. The current Annual Allowable Cut (AAC) is set at

Illustration 1: Map of the Kootenay-Boundary Land Use Plan Area.

(Original map courtesy of Nelson Region Office of the BC Ministry of Forests.)



Scale Approximately 1:2,100,000

2.9 million m^3. Common commercial timber species include ponderosa pine, Douglas fir, Engelmann spruce, western redcedar and western hemlock (Owen, 1994a:38). A total of 59 000 people live in the region, of whom 3500 are considered to be employed in the forest industry (Owen, 1994a:68).

2.4.2 West Kootenay-Boundary Region

The West Kootenay-Boundary region contains four forest districts: Revelstoke, Kootenay Lake, Arrow and Boundary. It is a mountainous region with several large lakes, and contains six ecosections. With certain exceptions within the Boundary area, the region is within the interior wet belt, with relatively high rainfall and mild winters, an unusual climate for interior mountainous regions. Due to disturbances from mining and past forestry operations, old growth is now concentrated in high elevation forests or in areas where timber extraction is difficult due to topography. The region currently supports caribou, grizzly, black bear, elk, mule deer and moose, while the alpine tundra supports mountain goat, wolverine and marten (Owen, 1994b:30-33).

The West Kootenay-Boundary region has a population of 90 000 people. The discovery of rich silver deposits led to an extensive network of railroads, incorporating almost all major valleys; these were complemented by many steamship routes. Nelson became an important supply centre. By 1970 logging roads reached into every major drainage in the West Kootenays, and soon resource conflicts became commonplace. Some of these early conflicts led to the establishment of the Purcell Wilderness Conservancy, and later the Valhalla Provincial Park. However, these protected areas contain relatively little of the ecologically rich valley bottom lands.

2.4.3 The Arrow Forest District

The Arrow Forest District, which contains the Slocan Valley, is made up of the Arrow Timber Supply Area (754 000 hectares), Tree Farm License 23 (473 300 hectares), and Tree Farm License 3 (79 500 hectares). It is located in the interior wet-belt; the three most significant biogeoclimatic zones are the Interior Cedar-Hemlock Zone, the Engelmann Spruce - Subalpine Fir Zone, and the Alpine Tundra zone. Due to steep terrain and sensitive soils, timber availability is considered limited over much of the district (Ministry of Forests, 1994:3). In 1991, the population of the Arrow Forest District was 42 145. From a socio-economic perspective, there are three key areas: Castlegar, a forest sector-dependent community; Trail, a smelter town; and the Slocan Valley, discussed in more detail below (Resource Systems Management International, 1994:iii).

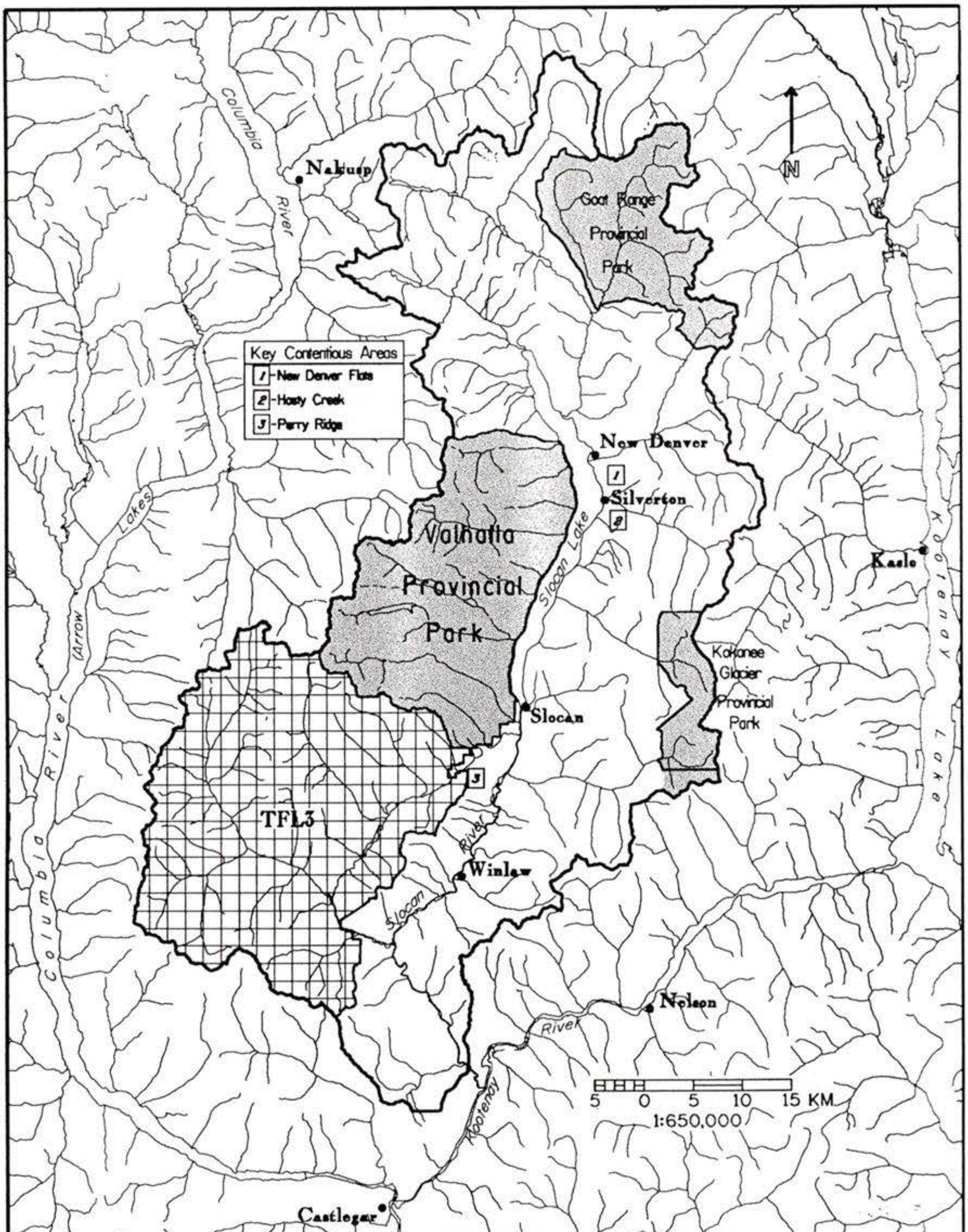
2.4.4 The Slocan Valley

The Slocan Valley is near the well-known town of Nelson in the Selkirk Mountains of the West Kootenays and lies within the Central Columbia Mountains Ecosection, a region noted for its deep trenches and narrow valleys. The Slocan River watershed covers approximately 340,000 hectares of land and water, draining into the Kootenay River, which is part of the Columbia River Basin. The main communities in the Valley are Slocan, Silverton, New Denver, and Winlaw. Across the Slocan Lake from New Denver and Silverton are the mountains of the Valhalla range, of which some of the most striking parts have been protected as the Valhalla Provincial Park (see Illustration 2).

The Selkirk Mountains, particularly in the northern portions of the watershed, are very rugged (Jungen, 1980:3), contributing to the scenic beauty of the area, and to the

Illustration 2: Map of the Slocan Valley

(Map courtesy of Jason Kubian and the Silva Forest Foundation)



limitations in the potential for commercial forestry. Due to the complex topography and geology of the region, it includes a wide variety of soils, most of which are made up of shallow deposits of coarse materials over bedrock, glacial till, or glaciofluvial deposits (Jungen, 1980:8-10). Much of the terrain is very unstable, and the slopes are susceptible to landslides or mass failure, especially when tree cover is removed (Hammond et al., 1996: Chapter 3, p. 6). In the valley bottom where glaciofluvial deposits are found, the land ranges from high to low agricultural capability, much of the better farmland presently being used for farming or homesteading. Most of the watershed is considered non-arable (Jungen, 1980:139), though this non-arable portion is considered productive forest land except where altitude limits growth (Jungen, 1980:157). Operable forest land makes up 36% of the total land area (Kootenay Resource Management Committee, 1983:64). Once private land, parks and other inoperable areas are factored in, the Ministry of Forests' Timber Management Land Base is equal to 29% of the total area (Hammond et al., 1996: Chapter 5, p. 5).

According to the Biogeoclimatic Ecosystem Classification system used by the Ministry of Forests, the Slocan watershed contains four biogeoclimatic zones[5]: the dry warm and moist warm Interior/Cedar-Hemlock; the Engelmann Spruce - Subalpine Fir; and the Alpine Tundra/Engelmann-Spruce wet cold parkland (Braumandl and Curran, 1992). According to Braumandl and Curran (1992) these zones can be characterized as follows:

- Dry warm Interior Cedar-Hemlock subzone (ICHdw)--with very hot, moist summers; mild winters with light snowfall resulting in shallow snowpacks. Growth is limited on dry sites by lack of moisture. This subzone contains the greatest diversity of tree species in the province, including western hemlock, western red cedar, lodgepole pine,

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[5] These zones are mapped at a 1:250 000 scale in Research Section, Ministry of Forests 1992. Biogeoclimatic Units, Map Sheets 82f and 82k, Nelson, B.C.

ponderosa pine, Douglas-fir, western larch, western white pine, black cottonwood, hybrid white spruce, and trembling aspen. Shrubs include saskatoon, oregon grape, Douglas maple, falsebox, black huckleberry, and devil's club. Herbs include prince's pine, twinflower, queen's cup, and wild sarsaparilla. Much of this zone was burned around the turn of the century by miners, so there is very little old-growth represented in this subzone.

- Moist warm Interior Cedar-Hemlock subzone (ICHmw2)--with hot, moist summers, very mild winters with light snowfall and moderate snowpacks; soils may dry out in the summer for a moderate period of time. Climate is not a major limit to growth, though lack of moisture at dry sites may present limits. Trees include western red cedar, western hemlock, Douglas-fir, western larch, lodgepole pine, and hybrid white spruce. Shrubs include saskatoon, falsebox, black huckleberry, oval-leafed blueberry, and black gooseberry. Herbs include prince's pine, twinflower, queen's cup, one-leafed foamflower, and common horsetail.

- Wet cold Engelmann Spruce - Subalpine Fire subzone (ESSFwc4)--the upper slopes of the mountains, colder and wetter than the Interior Cedar-Hemlock Zone, with more snow; return periods between fires are long so stand replacement occurs naturally through insects, disease and windthrow. The forest makes a transition to parkland at about 1900 m, at which point regeneration is difficult and tree growth very slow. Tree species diversity is low, limited mostly to Engelmann spruce, subalpine fir, lodgepole pine, and whitebark pine. Shrubs are dominated by falsebox, black huckleberry, white-flowered rhododendron, and Sitka mountain-ash. Herbs include Sitka valerian, mountain arnica, clasping twisted stalk, and Indian hellbore.

- Alpine Tundra/Engelmann Spruce-Subalpine Fir wet cold parkland (AT/ESSFwcp) zone--occurring at the highest elevations. The Alpine Tundra is largely made up of rock, talus, snow and ice, with areas of sparse vegetation, including willows, gaxifrages, pussytoes, and Sitka valerian, with occasional stunted conifers. At lower elevations of this zone, trees are widely spaced, and limited mainly to Engelmann spruce, subalpine fir, alpine larch, and whitebark pine.

Like the rest of the Kootenays, the forests of the Slocan Valley have been extensively modified by human activities. The Sinixt people are thought to have deliberately burned patches of forest to improve wildlife habitat and to favour berries and other culturally important plants. Large areas were burned off by prospectors before the turn of the century to expose minerals. Small scale logging operations were established to provide timber for mines and railways during the mining frenzy of the late 19th century and early 20th century. From the turn of the century to the mid-thirties, the Valley bottom was settled and cleared, and mills were established in Winlaw, Crescent Valley and Koch Siding to take advantage of the more accessible stands of timber. From then until 1964 various lumbering operations were consolidated. After 1964, the timber industry was dominated by a single, well capitalized player, now run by Slocan Forest Products, employing aggressive industrial forestry practices, and able to access timber extensively across the landscape, focussed on liquidating remnant stands of old growth (Evans, 1975:26-29; Hammond et al., 1996: Chapter 4, p. 10). During the period 1950 to 1994, 24 847 hectares were logged, of which 15% was on Ministry of Forest Environmentally Sensitive land, 7% on private land, and 33% on land the SFF labels as ecologically sensitive. Logging records prior to 1950 have supposedly been lost (Hammond et al., 1996: Chapter 5, pp. 45-47). SFF's analysis documents how little old growth forest remains in low elevation forest, or on stable and moderately stable terrain (Hammond et al., 1996: Chapter 5, p. 41). The forests of the Slocan Valley, except in high elevation stands or on steep slopes, can be characterized as young stands, mostly naturally regenerated or more recently replanted following human disturbance. Forests above 1200 m begin to face severe limits on growth due to the cold climate, cold soils, the deep snowpack and slow nutrient cycling (Hammond et al., 1996: Chapter 3, p. 7). Once future logging plans are taken into account, the proportion of old growth will further decline, being well below pre-contact values for such a landscape, even when considering what proportion would have been old growth following catastrophic fires or insect outbreaks. Mining, logging and settlement have resulted in an extensively fragmented landscape, with fragmentation most pronounced within the boundaries of Tree Farm License #3, which covers the Little Slocan River drainage.

The Slocan watershed enjoys hot summers and mild winters, with frequent melting periods during the winter except at higher elevations. The steep slopes of the Slocan Valley generally restricted human settlement to the narrow valley floor, and made transportation connections to neighboring valleys difficult. The valley bottom is warm enough and has a sufficiently long frost free season to allow for the cultivation of apples, pears, walnuts, plums, tomatoes, and strawberries, while black huckleberry grows wild. Because of the hot summers, farmers and homesteaders irrigate their crops, often with gravity-fed water from waterboxes that divert water from local streams running off the steep mountain slopes. Apparently because of turn of the century fires and logging, many of the smaller watersheds could not be counted on to provide water throughout the summer until the 1930s or 40s, when forest stands had sufficiently reestablished themselves (Tom Bradley, SFF forest technician, personal communication, June 26, 1996).

2.5 Logging and Conflict in the Slocan

In this section, I sketch some key parts of the logging history of the Slocan Valley. Each person would write a different history, emphasize different points and omit others, and I have no intention of providing a comprehensive account or of drawing on a wide variety of sources and perspectives. To keep this study at a reasonable length I do not address the conflict between indigenous peoples and colonizers,[6] nor more recent efforts by the Sinixt to be recognized in the Canadian portion of their traditional territory. The main intent here is to show the reader that land use and resource conflicts in the Slocan are not recent, that such conflicts have steadily escalated, and that little has been resolved, despite concerted efforts by citizens and a variety of government-sanctioned planning processes.

While miners often burned timber around the turn of the century to make prospecting easier, soon the timber became valuable in its own right. Oral histories of the early West Kootenay forest industry provide valuable insight into the history of resource extraction. The following accounts are taken from interviews with old-timers organized by the Kootenay Museum Association and Historical Society (1994).

Early logging did not use clearcutting; instead, as William Waldie, a former sawmill operator, recalled, trees were cut to a certain diameter limit:

> ...Nor did we clearcut. Mind you in my days there was no pulp. Chip markets didn't exists...Mills wouldn't be anxious to cut these six inch trees...Lot of places we cut they [earlier loggers] had cut way back, old rotten stumps four feet in diameter, three feet in diameter...Lots of places. And you know a lot of loggers were interested in that. Here we are cutting here and someone was here fifty years ago [logging the same site], and that seemed to please them.

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[6] Interested readers are referred to Wagner, 1997; Pryce, 1995; and Bouchard and Kennedy, 1985.

The words of one faller suggest that the forest industry has never practiced forest stewardship:

> The mistake the companies made was that they gutted the timber. Nowadays they talk about raping the old growth. All the companies have done for a hundred years is rape the forest. Everything that was left, they just bulldozed with Cats, getting out the logs. Then the forestry said to burn it, because if [they] didn't, the lightning would...

As the forest service asserted control, logging operations changed. Frank Hill, a former forest ranger explained the switch to clearcutting in financial terms:

> ...to wipe it all out with big machinery--which is big money--wipe it all out and take what you can sell and destroy the rest. But in the old days, they logged it with horses. The reason they want to clearcut now is to wipe it all out with big machinery and that defeats the purpose.

The forests of the Slocan Valley have been extensively logged, but little of the wood has been processed into value added products. Lumberjack Russell Fletcher recalled how white pine from the Slocan and other areas surrounding Nelson was brought in and partially processed into match blocks:

> W.W. Powell Company, they were a match block factory. They just bought the pine and seasoned it and remilled it and cut into match lengths in blocks...Someone clearing a little piece of land, and there was a carload of pine on it, white pine, and he'd take it down and he'd get about $17 a thousand board feet for it, which was quite a lot of money in them days.

The scale of early logging efforts is suggested by this description by former logging truck driver Bob Cunningham of a mill founded by the Patricks at the lower end of the Slocan Valley:

> It was an immense mill...it was the biggest mill in the interior at that time. One comment that I heard a number of times was that the mill

> was really too big for the logging methods of those days in this area. The logs had to be brought in quite a distance. Back in the bush it's a good twenty-five miles to Little Slocan Lakes.

Working hauling logs out of clearcuts throughout the West Kootenays gave Cunningham pause to reflect on the damage caused by logging:

> Almost everywhere I go here I look up a mountain and say, "Well, I've hauled out of that clearcut..." I was so busy in the trucking end of it that I didn't realized what clearcutting was doing to our area. Then after a while I began to take note of what was going on around me. I started off by saying, "Where do the birds and the bees and the chipmunks and the bears and everything go when we finish this area?"
>
> The next thing I noticed, the spring time of the year when I was going down the road, the creeks were bringing the mountainside with it, right along side of me and into the rivers. Earth that took who knows how long to create up there was coming down the mountain in a big wash and I began to get so aware and concerned about this...In my estimation the damage doesn't have to happen... We have innumerable springs in these mountains, and I think water more than anything is necessary for us to survive. If we don't have water, what good is the commerce?

The transition to clearcutting was sudden, and, rhetoric to the contrary, apparently not backed up by the ecological knowledge of the day. Buster Ross, a former forest manager, recalled the transition to clearcutting:

> I don't know why it was, but I know all of a sudden it was policy wherever possible to clearcut. The loggers found it easier to grasp what they needed and lay down the rest and I think it was their pressure that got away from the separate species or diameter cutting and that. But you know in the early days they figured they would never run out of timber. Now it's run out.

Early on, protecting domestic water supplies sometimes proved to be a contentious issue, and one that front line staff did not feel they had the power to deal with. Ross recalled that in one instance he put a clause in the sale to force the company to put in toilets during logging to protect domestic water supplies. His efforts failed.

> Didn't do much good because they went up the stream and left the toilet four miles below. They were in someone's watershed. That's why the health regulations. They even dumped their changed oil from their damn bulldozers...right...where it would run down into the creek... Many of them were always figuring ways to get around the regulations.

Large scale industrial forestry evolved in the Slocan Valley from a sawmill at Passmore. Once augmented with a planer mill, it met the requirements for a Forest Management License which was granted in 1950 for the area covering the Little Slocan River drainage. In 1964 the mill was sold to Pacific Logging Ltd. and moved to Slocan City. Since then the Valley's forest industry has been considered to be dominated by one player (Evans, 1975: Chapter 2, p. 29). In 1978 the mill was acquired by Slocan Forest Products, and the forest management license has been replaced with Tree Farm License #3. Evans documents the transition in the logging industry from an industry with many small operators bidding aggressively on timber sales and thereby increasing the province's stumpage, to an industry dominated by a single large player, no longer subject to competitive pressures in securing timber for the mill (see Evans 1975, Chapter 2). Small operators were left with immature timber on steep slopes, and gradually were forced out of the business.

In 1973, a group of Valley residents sought to find new ways of creating employment from forest use without degrading the forest. With a government grant in hand, they initiated the Slocan Valley Community Forest Management Project (SVCFMP). Their investigation of the Valley's forest and forestry sector, and proposals for community control of forest exploitation, was at the time seen by many other communities as groundbreaking. The SVCFMP study observed that already, by 1974, the high rate of cut was precluding the possibility of parks, game reserves, wilderness areas, and community or private woodlots. The study concluded,

> It is no longer possible to ignore the impact that results from single-purpose management. The removal of such an incredibly large volume of wood cannot possibly be sustained unless the PSYU (Public Sustained Yield Unit) is carefully managed, ecologically sound harvesting systems are utilized, and prime consideration is given to the long-term and often irreparable effects of logging...
>
> ...This allowable annual cut is calculated on the premise that optimum conditions exist throughout the PSYU and that the average 88 year rotation can be applied at all sites (Evans, 1975: Chapter 3, p. 22).

The study then expressed doubts that these optimistic premises would be borne out. Eighteen areas or categories of land and resource use conflicts were also documented (Evans, 1975: Chapter 3, pp. 85-89). The solution, according to the study, was to build on the long term interests in place of those who called the Slocan Valley home. As coordinator for the research project and now New Democratic Party (NDP) Member of the Legislative Assembly, Corky Evans, testified before the 1975 Nelson hearings of the Forest Resources Commission:

> The problem with forest management in British Columbia that we are all discussing is partially just a problem of time and vested interest. Companies on a ten year write-off and governments on a five to twenty [sic] year election term, are simply too young and simply too transient to require more than one forest rotation to protect their capital or their power.
>
> The Slocan Valley local community, on the other hand, needs that forest for all their very survival needs, and for our employment and for our children's employment, and thus our vested interest is one of permanence (Royal Commission on Forest Resources, 1975: Vol. 10, p. 1625).

The study did not result in any substantive changes. As the foreword of the study had noted with respect to past efforts at reform, "sound forest management proposals, when in conflict with economic considerations, were usually not implemented."

Over the next decade, industrial forestry continued to extract timber unabated, though local organizing kept logging out of many watersheds. The severity of conflict and the commitment of some residents to change became clear in 1991 when 83 people were arrested for blocking a logging road at Hasty Creek. Many Valley residents were hopeful that, with the election of a new NDP government in 1991, communities would be given more power in land use and timber extraction decisions. The new MLA, Corky Evans, formerly the coordinator of the Slocan Valley Community Forest Management Project, was on record calling for community control. In his maiden speech to the legislature, Evans said,

> I'd like to suggest that in the next four years or, maybe in the next eight...we've got to stop the hemorrhage in wealth in those areas that the cities have always plundered in this province...We've got to put the patient at rest, and to me that means annual allowable cut reductions... We want communities to decide what is good for communities (Hansard, 1st session, 35th Parliament, Vol. 1 No. 9, March 25, 1992).

When the new NDP government created the Commission on Resources and the Environment (CORE), largely to resolve or defuse such conflicts, two CORE processes affected the Slocan Valley. At the regional level, a West Kootenay-Boundary Land Use Plan was to be prepared. A local CORE process was also set up specifically for the Slocan Valley. Because of past experience and because issues of tenure and the rate of cut were declared non-negotiable, some advocates of reform were skeptical of such processes and directed their efforts elsewhere. Others participated in good faith. The optimism that CORE would help to change forest management and resolve conflicts is reflected by the Applied Ecological Stewardship Coalition in their recommendation calling for the continuation and expansion of CORE, as it was

> ...the first opportunity that rural women in all sectors have had to freely participate in provincial policy recommendations, and has constituted a major advance for gender parity in BC. This advance

> may be lost if the invaluable CORE infrastructure were to be dissolved (MacIntyre, 1994: vi).

One of the Slocan Valley Watershed Alliance's main contributions to the CORE tables was to put forth the Silva Forest Foundation's ecosystem-based planning approach. Although the plan itself was not completed until the summer of 1996, the maps setting out the past disturbance and the ecosystem-based landscape plan were presented to the local CORE table in February and October of 1994.

However, the table did not recommend the ecosystem-based plan for adoption. By the end of the CORE process, many of the reform-minded participants were bitter and disillusioned, feeling that much of their effort in preparing for and participating in meetings had been wasted. The CORE recommendations were to be implemented in the Kootenay-Boundary Land Use Plan Implementation Strategy (KBLUP-IS). However, as a government backgrounder on the implementation strategy noted, a theme common to most public submissions commenting on the draft implementation strategy was that

> ...the [draft] KBLUP-IS is inconsistent with the intentions of the CORE process. Most who expressed this view believe the KBLUP-IS does not provide the level of management for environmental values which was defined through the CORE process. In particular, there is concern over the meaning of Special Resource Management Zones and whether resource management will be significantly different than elsewhere. ...the general feeling was that the KBLUP-IS will not achieve such sustainability (Land Use Coordination Office, 1997).

In the KBLUP-IS, much of the Valley was designated as a Special Management Zone. The intent of this zone, as expressed by the local CORE table, was that within Special Management areas, low-intensity land use with an emphasis on water quality protection would be allowed, and that community resource boards would be set up to determine how water quality and other values could be protected. However, public input was not sought in the writing of guidelines covering this zone, and the 1996-2000 forest development plan was announced prior to the guidelines being published. The forest development plan would allow 144 cutblocks in the Special Management Zones over the five year period. Not including TFL#3, an area the plan dedicates to industrial forestry, over 139 clearcuts were proposed for the Slocan Valley. Only 12 cutblocks would involve selection logging, while 42% of cutblocks would be on slopes of 60% or greater (Pettitt, 1996).

Concurrent with the CORE process and the development of the KBLUP Implementation Strategy, the Ministry of Forests proceeded with Timber Supply Reviews and the Chief Forester handed down the AAC determinations. Because this process defines the AAC, it has a marked influence on industry activity across the landscape. The Arrow Timber Supply Review and the Rationale for the Arrow TSA AAC determination (Pederson, 1995) both indicate a reluctance to reduce the AAC, despite eight reasons that might require a drop in the AAC. These reasons include: probable impacts on the productive landscape of forthcoming land use designations, of watershed protection requirements, and of the possible need to move from a three- to a four- or five-pass harvesting system. Modelling of such requirements suggests that falldown[7] would be brought forward from seven decades hence to as soon as within the decade (Pederson, 1995:35-36). Yet the AAC for Arrow TSA was left unchanged. The Chief Forester indicates concern that because of contentious land use issues, logging in certain areas has been avoided; to address this concern he requires that district staff "identify appropriate harvest targets for areas in which harvesting has previously been avoided" (Pederson, 1995:35-36).

Over the past twenty years, the Slocan Valley Watershed Alliance, the Silva Forest Foundation and the Valhalla Society, and many Valley residents, have sought to change forest practices and management plans in the Slocan Valley. This has included outreach to educate the community on forest ecology and the alternatives to the industrial approach.

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[7] Falldown is the time when the AAC drops from the high levels made possible by liquidating old growth stocks to a lower level that can supposedly be maintained in perpetuity by cutting the plantation forests that replaced the liquidated old growth forests.

Numerous studies were commissioned, including: forest mapping and analysis; biological and hydrogeological assessments; and the Silva Forest Foundation's ecosystem-based plan. Community members have also been involved in monitoring water flow and quality for numerous creeks. Such efforts have resulted in an informed and concerned population. A poll conducted in the summer of 1996 by Angus Reid determined that the top three issues facing the community were: forestry (46%); water quality (30%); and environment/ pollution (22%), contrasting markedly with the provincial statistics, where the main concerns deal with the economy rather than the environment. The top three environmental issues noted in the Valley were: watershed logging (35%), clearcut logging (23%) and forestry (22%). Only 36% of the population supports current government and industry forest plans. After hearing some of the main ideas behind the SFF plan, 75% of respondents said they would strongly or moderately support the plan, while only 11% were likely to oppose it. The Reid group also sought to gauge public support for the main ideas underlying the SFF plan, and noted:

> Overall, Slocan Valley residents overwhelmingly support and approve of the ideas underlying the Silva Forest Foundation plan. At least 7 in 10 people would either moderately or strongly agree with all nine of the attitudinal statements representing some of the ideas in the Silva Forest Foundation plan....given what we understand about the public opinion context within the Slocan Valley--the concern about the watershed [sic], water quality and forestry--support for the plan and its basic ideas makes a great deal of sense. The general feeling from this data seems to suggest that the Silva Foundation plan is seen to be a relevant and timely solution for the resource management issues and problems facing the Valley... (Angus Reid, 1996: 14-15).

Beyond opinion polls, the villages of Silverton and New Denver, and the regional representative for the Regional District of Central Kootenay, have all put on the record their dissatisfaction with status quo logging plans (Village of New Denver, 1997; Village of Silverton, 1997). The land itself has also expressed its reaction to the status quo. The BC government settled out of court for a "nuisance" created by Ministry approved logging, paying for damages in the 1990 Memphis Creek slides. A new avalanche path was created by a one year old clear cut at Ranch Ridge in 1988, and a similar incident occurred within a few weeks of clearcutting on Frog Peak in 1994. Private logging initiated a mudslide into Silverton Creek in 1994 (Sherrod, 1996:9-10). A Lemon Creek water-user is pursuing legal action to remedy the loss of his domestic water supply due to a landslide that occurred in the spring of 1997 (Susan Hammond, personal communication, December 15, 1997). Some Valley residents claim that logging has already caused their water supply to deteriorate, and a scientifically designed citizen water monitoring effort is underway to be able to substantiate future logging-induced degradation.

Despite public dissatisfaction with the status quo and broad support for the principles behind the SFF plan, despite evidence of ecological deterioration in the Slocan Valley due to industrial forestry, despite looming shortfalls in timber supply, despite twenty years of hard work, by the spring of 1997 it was clear that the government intended to proceed with proposed plans. Unreformed industrial logging would take place in the watersheds and in other sensitive areas, even if the government had to resort to strong arm tactics to provide industry with access to timber despite community opposition. The local MLA Corky Evans, who in the 1980s had been such an advocate of community control, was in full support of government plans, casting the environmental movement in the Valley as a cult (Sherrod, 1997).

2.6 Context and the Role Played by Economic Analysis

It is in this complicated ecological, social and political landscape that one must look at the role of and methods used for economic analysis of land use options in BC. There are at least three perspectives from which natural capital can be seen. For those community members who equate their future well-being with the well-being of the Valley ecosystem, natural capital is a complex bundle of interrelated ecosystem components providing diverse ecological services and flows. For Slocan Forest Products, natural capital is a stock of timber from which flows can be extracted to derive profits, even if this means degrading natural capital as it is more broadly conceived. For timber industry workers, and for the Ministry of Forests, the perspective is that natural capital must be managed so as to provide for the continuing viability of the forest industry, though broader considerations have a weak influence in attenuating this narrow focus. Economic analysis is applied in a forum where there are wide divergences in values, in interpretations of resource stewardship, in priorities, in power. This contrasts markedly with the educational experience of economists. Chances are that the student of economics has been presented with a view where economics plays an ethically neutral role in the decision process, merely providing participants with an objective analysis of the consequences of alternative courses of action, thereby contributing to better and more rational decisions (Hausman and McPherson, 1996: 209-220). The Slocan Valley offers an excellent opportunity to examine the role that economic analysis plays in land use and resource extraction decisions. It allows one to test the proposition that economic analysis in the context of a multiple accounts framework can contribute to better and more rational decision-making in resource extraction and land use disputes. It further allows one to explore how changing such analysis to require explicit attention to natural capital stocks and sustainability might contribute to sustainable patterns of land and resource use. Finally, it allows one to examine how the values, visions, and suppositions of economists themselves frame the debate and influence outcomes.

Chapter 3: The Need to Incorporate Strong Sustainability into Economic Analysis

3.1 Chapter Overview

The intent of this chapter is to establish the need for economic analysis of renewable resource exploitation options to be consistent with long-accepted principles of economics. as well as with more recent insights from ecological economics. It will be argued that economic analysis should address the economic and social imperatives of maintaining natural capital intact. Two approaches will be used to document why such a major change is needed in the way economic analysis of renewable resource extraction is undertaken.

The first approach is to establish that sustainability is implicit in classical and neoclassical definitions of income. As will be documented below, income is commonly understood by economists to be that which remains available for consumption over a given period once one has ensured that the future flow generated by one's stock of capital will not be diminished. Economists generally restrict the interpretation of this definition to manufactured capital only. However, careful consideration of what is implied by income and capital, and of the conditions required for production and sustainability, supports the conclusion that in income determination, the stock of natural capital must also be considered. Yet while analogies can be drawn between manufactured and natural capital. the two are very different. Taking this, and the impossibility of finding a theoretically defensible means to value aggregate natural capital stocks, into account, the conclusion that natural capital should be maintained intact is offered here as a metaphor to guide human conduct and to reform methods of economic analysis, not as a strict theoretical or analytical proposition.

The second approach is to argue that since sustainability has been adopted as a societal objective, internationally, in Canada, and in British Columbia, economic analysis must be modified to take sustainability into account. Sustainability is a social goal, for which economics should be instrumental. Again, it will be shown that in order to achieve this societal objective, it is essential that the stock of natural capital be maintained intact.

The task then turns to setting out in more detail what the maintenance of natural capital requires and implies, ecologically, and how economic analysis should account for the failure to maintain natural capital. This discussion is grounded by reference to the Slocan Valley case study, intended to provide "recurrence to the concrete in search of inspiration" (Whitehead cited in Daly 1992:285) so as to avoid excessive abstraction and the fallacy of misplaced concreteness.

The discussion which follows is complicated by the fact that the stock of natural capital includes both renewable and non-renewable resources. As this research project is focused on forestry resources, this chapter will be limited to considering the exploitation of so-called renewable resources. Given the way in which the "limits to growth" debate originated, this focus on renewable resources may at first appear counter-intuitive. When Limits to Growth (Meadows et al.) was published in 1972, the debate which followed focused on the likelihood that future shortages of non-renewable resources such as oil and minerals would bring economic growth to a halt. At the global level it appears that shortages of non-renewables are not likely to hinder growth in the near future. Indeed, known reserves of most non-renewables have increased since 1972, while their price has dropped in real terms.[8] The problem then is not so much that the exhaustion of non-renewables will impede sustainability. Rather, the problem is that supposedly renewable

[8] However, one should not conclude that non-renewable resource extraction could not impact the global economy. Recent analysis by Campbell and Laherrère (1998) suggests that world oil production will peak by 2010, leading to the potential for another energy crisis and related economic difficulties.

resources are being harvested in a way which will lead to exhaustion. Renewable resource extraction technologies are often unselective and wasteful of natural capital, while the waste products of non-renewable resource use contaminate and overburden ecosystems globally (Dobell, 1993:7; Victor et al., 1995:89). The limiting factor for sustainability, given our current socio-economic system, is therefore declining levels of renewable natural capital. Exhaustion of non-renewable natural capital will, in many instances, only become a problem if humanity survives the next fifty to one hundred years. It is therefore legitimate and appropriate for this research project to be entirely focused on renewable natural resources. Future generations are less likely to be concerned that we used more than our fair portion of coal stocks, such that they will have less than their fair share of coal to burn; they are more likely to be concerned that we have thereby passed on a warmer planet, denuded of forest ecosystems.

3.2 Strong Sustainability and Prudent Economic Behavior

3.2.1 Sustainability in the Classic Economic Texts

El Serafy reminds us that maintaining capital intact, "is central to all economic behavior and analysis, and it is a poor economist indeed who is unable to tell capital from income." The accounting profession arose in the Middle Ages out of the need of merchants to differentiate between income and capital, in order to ensure that they did not consume their capital and thereby endanger future personal and commercial well-being (El Serafy 1989:11; Hicks, 1974). Adam Smith recognized the importance of maintaining the stock of capital, defining net revenue as that which remains free for the use of inhabitants "after deducting the expense of maintaining" their capital and ensuring that they were not "encroaching upon their capital" (Smith, 1937 [1776]).

Potvin also suggests that economists should reread early political economists to see how the importance of sustainability has long been noted. He refers us to Ricardo, whose definition of economic rent was "clearly payment for sustainable use of the land" (Potvin, 1990:14). Ricardo took issue with Adam Smith's loose application of the term rent in instances where timber, stone or coal was being removed from the land:

> If, indeed, after the timber was removed, and compensation was paid to the landlord for the purpose of growing timber or any other produce, with a view to future demand, such compensation might justly be called rent, because it would be paid for the productive powers of the land; but in the case stated by Adam Smith, the compensation was paid for the liberty of removing and selling the timber, not for the liberty of growing it (Ricardo 1973 [1817]:33-34).

No less than one of the fathers of neoclassical economics, Alfred Marshall, recognized the contribution of nature to production, and would not have been averse to charging the depletion of renewable resources as capital depreciation (El Serafy, 1993a:17). Potvin suggests that Marshall had observed and cautioned against the growing tendency of his contemporaries to reduce the three classical factors of production--land, labour, and capital--to just two by dropping the first. He cites Marshall's admonition against assuming that land could be ignored in the analysis:

> ...this illustrates the fact that land from the point of view of the individual cultivator is simply one form of capital. ... Now if the nation as a whole finds its stock of planing machines or ploughs inappropriately large or inappropriately small, it can redistribute its resources. It can obtain more of that in which it is deficient, while gradually lessening its stock of things as are superabundant; but it cannot do that in regard to land; it can cultivate its lands more intensely, but it cannot get any more. ... These considerations lead us to repeat that, whether in an old or a new country, a far-seeing statesman will feel a greater responsibility to future generations when legislating as to land than as to other forms of wealth; and that, from the economic and from the ethical point of view, land must everywhere and always be classed as a thing by itself (cited in Potvin, 1990:15-16).

Daly relies upon Sir John Hicks to argue that a concern for sustainability is built into the concept of income (Daly, 1992b:248). Hicks writes,

> The purpose of income in calculations in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves. Following out this idea, it would seem that we ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning (Hicks, 1946:172).

From Hicks, Daly argues, it can be seen that remaining equally well off requires that capital (the source of future income) be maintained intact. Hick's definition of income has influenced Canadian public policy. For instance, the Royal Commission of Taxation proposed a definition of income for tax assessment purposes that is consistent with Hick's definition (Royal Commission on Taxation, 1966:Vol. 1, p. 4-6). There is therefore no "paradigm shift" required to incorporate sustainability into economic analysis (Potvin, 1990:17). The problem is that while economists have accepted this principle, they have failed to apply it to the category of natural capital (Daly, 1992b:249).

Past experience also indicates that it is unwise to treat the depletion of natural capital as income. For instance, Repetto refers to the small atoll republic of Kiribati, where phosphate mines provided the bulk of government revenues. Mining revenues were treated as income, rather than as the proceeds from capital consumption. When the mines ran out, government revenue declined precipitously (Repetto et al., 1989:20). A related manifestation of the problem of public policy which treats the depletion of natural capital as income is the so-called "Dutch disease." High levels of revenue from rapid drawing down of natural capital encourages spending on nontraded goods, distorts the economy, stifles diversification, and slows down the developments of exports that are not resource intensive (El Serafy, 1989:17; Corden, 1984). At a minimum, then, a Hicksian approach to capital theory requires that income be seen as that which can be consumed while maintaining the sum of natural capital and manufactured capital intact. If natural capital is used up, it must --in order to maintain future income--be offset by the accumulation of an equal value of manufactured capital. Daly labels this minimal approach as "weak sustainability" as it is based on the assumption that manufactured capital can readily substitute for natural capital. "Strong sustainability" would require that both manufactured and natural capital be maintained intact separately.

Reference to Smith, Marshall and Hicks cannot settle the question of whether the concept of constant income requires that the sum of natural and manufactured capital be maintained intact, or whether natural capital must be maintained intact separately. However, careful analysis of the assumptions behind weak sustainability shows that it is an inadequate criterion and that strong sustainability is required. First, it should be noted that when Hicks defined income, he was living in a world where human activity drew much less upon natural resources and imposed fewer impacts on the biosphere. Concepts and tools of economic analysis developed for an "empty" world need to be changed to fit the realities of a "full" world (Daly, 1992:201-205; von Amsberg, 1994:127; van Dieren, 1995:236).

However, as early as 1926, chemist-turned-economist Frederick Soddy identified key problems with the concept of weak sustainability, though in the context of a different debate. Soddy demonstrated how economists often mistake real capital for financial capital. He pointed out that payment of interest could only arise either by economic growth or by debtors being impoverished. Economic growth depends on physical factors--materials and energy (Soddy, 1926). His critique points to a fundamental flaw in the weak sustainability propositions. As natural capital is depleted, it must be replaced with manufactured capital if the constant total capital rule is to be respected--it cannot be merely held as financial capital. This manufactured capital requires natural capital for its manufacture, operation and maintenance. Hence increased quantities of manufactured capital tend to require increased quantities of the very resources that are being depleted (Martinez-Alier, 1987:13). Whether continuing substitution in this manner is physically feasible is an empirical question, explored in the next section.

3.2.2 Are Natural and Manufactured Capital Complements or Substitutes?

Fundamental to the concept of "weak sustainability" is the assumption within neoclassical economics that manufactured capital can substitute for natural capital. This position is usually supported in the following way. As natural resources become scarce, their prices will rise and substitutes will be used. Furthermore, services formerly obtained freely from nature, such as the water purification services provided by a wetland, can be replaced by manufactured capital such as water filters and sewage treatment plants. According to the neoclassical argument, future generations cannot object if we leave them with less natural capital than we inherited if the natural capital we consume is offset by appropriate additions to the stocks of manufactured capital (Solow, 1993:181; Daly, 1992b:250).

Here, two issues need to be addressed. One is whether, and how readily, manufactured capital can substitute for natural capital. The other is whether future generations will be able to benefit from increased levels of manufactured capital. To address this second issue, Daly turns to Irving Fisher's conceptualization of capital and income, which involves a subtle variation of Hick's definition. Fisher holds that capital is the stock of all material objects held by humans at a given instant of time; income is the flow of service provided over a period of time by this capital (Daly, 1992b:32). From Fisher's perspective, a piano or an overcoat manufactured in a given year is not part of the national income; rather, they represent an addition to the stock of capital. Only when the piano or overcoat provides service to its user, is income increased (Pigou, 1920:35, cited in Daly, 1992b:202).

From a Fisherian understanding of capital and income, Boulding, Georgescu-Roegen and Daly draw several conclusions. It is not the process of production or consumption that should be considered valuable, as production and consumption involve additions or subtractions from the stock of manufactured capital and are in fact undesirable, as they involve the creation of waste products. When a house wears out (due to entropy), its maintenance and replacement is a cost. Nor is the size of the stock valuable in itself: if a smaller housing stock can provide a given level of service, there is no value in switching to a state in which many more houses are required to provide the same level of service. It is the service provided by the stock that humans value (Boulding, 1949:79 cited in Daly, 1992b:203). Furthermore, increased stocks of manufactured capital require increased throughput of resources to counteract the second law of thermodynamics, putting higher demands on natural capital (Georgescu-Roegen, 1993 [1971]:85; Daly, 1992b:203). There is no reason to emphasize increasing the total stock of manufactured capital (larger houses). Rather, the emphasis should be on increasing the efficiency with which the stock provides service (people happily sheltered in modest homes), and to decrease the rate at which the stock must be maintained and repaired (well-built, long-lasting houses requiring fewer natural resources) (Daly, 1992b:78-79).

To return from the theoretical to the concrete, several observations can be made from this Fisherian perspective that have a bearing on the present argument. Future generations may well curse the abundant stocks of manufactured capital which are our legacy. Highways in a world with little oil, or in a world where carbon emissions must be severely curtailed, will be liabilities, not assets (Norgaard, 1993:28). Furthermore, much of modern infrastructure, from sprawling suburbs, to energy-inefficient buildings, is notoriously inefficient in its use of scarce but unpriced natural capital. The stock of inefficient manufactured capital may well prove to be a liability to future generations. The resource demands merely to offset the depreciation of the large stocks of manufactured capital passed on to future generations may turn out to be unbearable. For instance, maintaining North America's network of highways, streets and sewers is already proving to be beyond the capacity of many governments. If maintenance costs incorporated more of the ecological costs of obtaining the resources necessary for such maintenance, maintenance budgets would likely be overwhelmed. Finally, future generations may learn that more satisfaction and well-being are provided by the likes of a modest home in a close-knit community drawing on pooled common areas, rather than by monster homes with private amenities. Thus stock size is of limited relevance in itself.

For the above reasons, there is a consensus in the ecological economics literature that opportunities to substitute natural capital with manufactured capital are now extremely limited. Indeed, it appears we may already have overshot ecological limits (see Meadows et al., 1992). This is especially so now that patterns of scarcity have been reversed. Whereas our ancestors lived in a world of abundant natural capital, and scarce manufactured capital, the economic system has grown to the point where natural capital is the limiting factor (Daly, 1992b:22). Within the neoclassical literature, however, the assumption that manufactured capital can substitute for natural capital is often either implicitly or explicitly made.

The characterization of manufactured capital as a substitute for natural capital has been criticized on several fronts. Much of the literature advocating weak sustainability (and hence assuming substitutability) relies upon Solow and Stiglitz's exploration of the conditions under which finite natural resources would not set bounds on prospects for economic growth. Their analysis was based upon a restrictive set of conditions unlikely to hold true in actual circumstances of economic production, including the assumption that there was a high degree of substitutability between natural and manufactured capital. Solow justified this latter assumption on the basis of an "educated guess" (Cabeza Gutés, 1996:153). Trying to demonstrate that it is only the total stock of manufactured and natural capital that matters in assessing sustainability, by beginning the analysis with the implicit but often unacknowledged assumption that the two stocks are substitutes, assumes the very outcome that one is attempting to prove (Victor, 1991:194; Cabeza Gutés, 1996:151). If the assumption that manufactured capital and natural capital are substitutes holds true, then by extension it should hold true that manufactured capital is not necessary for production, as all manufactured capital could be substituted with natural capital (Daly, 1997:263). Furthermore, this assumption implies that there would have been no reason for past generations to have put so much effort into converting natural capital into manufactured capital; people would be as well off with one or the other (Daly, 1994:25).

Several arguments are advanced by ecological economists and others to characterize natural and manufactured capital as complements, rather than substitutes. Pearce and Turner argue that natural capital is often needed to make manufactured capital; that natural capital is "multifunctional", providing both resources and global life support services, unlike manufactured capital; and that there may be many natural resources for which the fairly smooth substitution between inputs assumed by neoclassical theory may simply not apply (Pearce and Turner, 1990:49). Indeed, such discussions can be clarified by distinguishing between the different forms of natural capital; as a stock which provides inputs (such as coal, ore and timber) to productive processes, and as a stock which provides ecological services. However, much of the early work on substitutability focussed on natural capital as providing non-renewable inputs to the production process, neglecting the role that natural capital plays as the stock that provides renewable resource flows and ecological services. By investing in manufactured capital, it is often possible to improve the efficiency of resource use in the productive process, in which case a limited form of substitution occurs. Rarely is it possible to effectively substitute the natural capital which provides ecological services with a manufactured equivalent. From pollination to nutrient cycling, we remain dependent on natural capital (Prugh, 1995:68).

Victor confronts the issue of substitutability by critiquing the neoclassical approach to examining the potential for the depletion of exhaustible resources to impose limits on economic growth. Production at the aggregate level is most often examined from a neoclassical perspective by using a Cobb-Douglas production function. Yet, because this type of production function assumes a constant unitary degree of substitutability between inputs, the analyst cannot, in fact, use this type of production function to examine substitutability. Furthermore, some neoclassical analysts have conceded that if one takes capital depreciation into account, Cobb-Douglas functions can imply that consumption will eventually have to fall to zero. Finally, neoclassical analysis frequently fails to recognize that producing and operating manufactured capital requires natural resources (Victor, 1991:197).

In order to determine the implications of a more realistically specified neoclassical model, Victor uses a production function that explicitly recognizes the need for natural resource inputs to create and operate manufactured capital. By solving for capital he obtains a production function where output is a function only of resources and labour, and it becomes clear that "any possibility of solving a problem of depleting resources through substitution with capital has evaporated" (Victor, 1991:198). Kaufmann (1995) uses a neoclassical growth model to compare the short and long-run effects of environmental degradation on economic activity, and concludes that "it is not possible to substitute capital for environmental life support and maintain material well being."

In a recent, spirited exchange in Ecological Economics, Stiglitz admits that the models he and Solow were using in the 70s to consider limits to growth were only meant to be valid for a period of 50 to 60 years, even though they were written as if extending out to infinity (Stiglitz, 1997:269). Neither Solow nor Stiglitz responds to Daly's challenge (Daly, 1997) to address the substitutability issue head-on. Commentators to the exchange make a number of important points. The model may indeed work for a period of 50 to 60 years, but during that time, the ratio between natural capital and manufactured capital may change dramatically, impairing the level of production and well being (Tisdell, 1997:289). Furthermore, Solow/Stiglitz type models require elasticities of substitution not less than unity, yet empirical evidence indicates that for natural capital yielding ecological services (as opposed to stocks of coal or ore), elasticities of substitution may not be zero, but they are considerably less than one. Furthermore, in assessing sustainability, the time frame of interest is considerably larger than 60 years (Pearce, 1997).

The substitution argument can also be approached from a practical angle. If manufactured capital can substitute fully for natural capital, then we need not worry about natural capital depletion so long as conventional economic indicators show continued improvement. Indeed, as I write this chapter, North American stock markets set record highs, while resource prices have not increased markedly in real terms in the last twenty years. From the economic indicators, human prospects appear, for the most part, to give cause for optimism (Simon, 1998). Yet as Victor et al. (1995) point out, it is not by examining conventional economic indicators that scientists have concluded that the economic system is unsustainable. Rather, concerns about sustainability emerged as scientists examined ecological indicators, and as people in various parts of the world experienced the consequences of ecological degradation. If economies can appear to be strengthening at the same time as long term prospects for human survival appear increasingly bleak, it becomes apparent that the substitution of natural by manufactured capital currently taking place is creating conditions inherently unsustainable. This would seem to indicate that manufactured and natural capital are best seen as complements, not substitutes, and weak sustainability should be rejected in favour of strong sustainability (Victor et al., 1995:82).

Examples of possibilities for substitution, such as bricks substituting for wood in home construction, have been offered in the past to challenge the notion that natural capital and manufactured capital are best seen as complements. As Daly points out, by appealing to everyday concepts, such examples do not address the question:

> The issue is not substitution between two types of natural resources, rather it is one of substitution of capital for resources, an entirely different matter... We might say that Solow's recipe calls for making a cake with only the cook and his kitchen. We do not need flour, eggs, sugar, etc., nor electricity or natural gas, nor even firewood... If we want a bigger cake, the cook simply stirs faster in a bigger bowl and cooks the empty bowl in a bigger oven that simply heats itself (Daly, 1997:261).

In the context of the issue at hand, more pulp mills will not produce more pulp unless there is the wood fibre to feed the mills (Cleveland and Ruth, 1997:206). Of course, newer pulp mills may be more efficient in their utilization of the basic productive capacity of the biosphere--the next issue that needs to be addressed.

3.2.3 Technological Progress and Prospects for Substitutability

Related to the issue of substitutability is that of technical progress. Barnett and Morse argued in 1963 that technological progress would be applied to offset problems caused by resource depletion and pollution. Increased efficiency would allow a given quantity of natural resources to provide a greater amount of service and useful products. Without addressing the technological progress argument in detail in these pages, a number of observations may be made. Viable technologies are constrained by the laws of thermodynamics, and hence offer limited possibilities to extend resource use, and perpetual-motion type discoveries will not be made. Technological progress requires investment in education, in new tools, machines, and factories. Each of these investments in turn draws upon natural resources (Georgescu-Roegen, 1979b). While efficiencies due to new technologies are often noted when examined on a small scale, such as the use of additional insulation in homes reducing the need for fuel in the household sector, when examined on the broader scale of the entire economy, the fuel and resources needed to manufacture, transport, install and dispose of this insulation shows that at the economy-wide level, net substitution of insulation for fuel is much reduced (Cleveland and Ruth, 1997:208). Empirical research suggests that technological progress often largely results in the displacement of resource depletion from one sector of the economy to another. For instance, capital investments in the US forest industry to increase fuel efficiency over the period 1958 to 1984 were mostly offset by the energy incorporated in the capital itself (Cleveland and Ruth, 1997:209).

Other researchers have concluded that dramatic--four to ten fold--improvements in resource efficiency are not only feasible with existing technologies, but that they would pay for themselves (von Weizsäcker et al., 1997). At the same time, these researchers do not see such technologies as removing resource constraints, but rather as addressing an urgent need to shrink the ecological footprints of nations, and of the developed nations in particular (Wackernagel et al., 1997).

Homer-Dixon (1995) argues that technological progress, and in particular the application of technology towards the solution of practical problems, depends heavily on social ingenuity. Resource scarcities and environmental deterioration tend to increase social frictions and to reduce society's ingenuity in applying technology to address such problems. Therefore, when the prospects for technological innovation and change are considered in the context of the role that ingenuity plays in social adaptation to resource scarcity, a premium is placed on the prevention of future resource scarcities and hence on the maintenance of natural capital (Homer-Dixon, 1995:606).

While technological progress may help identify less harmful technologies, e.g., substitutes for CFCs, it does not allow one to substitute the ozone layer or other critical natural capital with manufactured capital, except to a very limited degree, e.g., sunscreen and hats. Furthermore, technology often puts further restrictions on natural capital use. For example, ozone monitoring equipment provided humanity with evidence that the atmosphere could not be treated as an unlimited sink for waste CFCs (Daly, 1992a). While a given technology may extend the use of natural capital, it also creates byproducts and has a tendency to create a new set of environmental problems which further burden natural capital (Popper-Lynkeus, 1888, cited in Martinez-Alier, 1987:197; Daly, 1992b:107), problems that may not be noted until natural capital has been further depleted. Technologies often remove one resource constraint at the expense of generating several others. For instance, green revolution agriculture was able to increase food production by replacing diversified cropping systems that evolved over long time frames with simplified monocultures. The older, diversified cropping systems have been shown to have maintained local biodiversity for extended timeframes prior to colonization. If monoculture agriculture is used, then extensive nature reserves are required to maintain biodiversity, for which no additional land exists (O'Neal et al., 1995).

Technology brings with it a set of cultural attitudes and assumptions, and prescribes certain behavioural and economic arrangements which may disrupt existing culture and social capital at the expense of a society's ability to manage resource extraction for sustainability (Gearhart, 1983). Technological progress also requires time for diffusion (Homer-Dixon, 1995:604). For instance, the energy crisis of the 70s sparked a number of innovations in the design and construction of passive solar heated homes, intended for the harsh Canadian climate, that were not significantly more expensive than standard homes. Yet despite the financial viability and environmental benefits provided by such homes, even today solar gain is not taken into account in most new home construction. Finally, the experiment with Biosphere 2, in which eight humans were kept with great difficulty in an isolated self-sustaining environment for two years, at a cost of $150 million, suggests the expense involved in replacing natural capital with manufactured capital (Avise, 1994).

Given all the limitations which appear to temper the prospects that technological innovation will remove constraints on drawing down natural capital, ecological economists have adopted a prudently skeptical attitude toward technology:

> ...it is irrational to *bank* on technology's ability to remove resource constraints. If we guess wrong, then the result is disastrous--irreversible destruction of our resource base and civilization itself. We should, at least for the time being, assume that technology will *not* be able to remove resource constraints. If it does, we can be pleasantly surprised (emphasis in original, Costanza et al., 1991:7).

3.2.4 Implications of Maintaining Natural Capital Intact

It appears then that the argument that natural and manufactured capital should be considered complements, rather than substitutes, while perhaps not entirely conclusive, is certainly persuasive. If, at this present stage of human history, natural and manufactured capital are best seen as complements, then sustainability must be of the strong variant, and economic behaviour that is consistent with the accepted definition of income requires that most natural capital be maintained intact. If this is the case, then it is essential to inquire in more detail into what maintenance of natural capital implies. Pearce and Turner identify four possible interpretations, each of which they admit has shortcomings:

1) the physical quantity of natural capital does not change

2) the value of the stocks of natural capital in real terms does not change

3) the unit value of the services provided by natural capital, as measured by natural resource prices, does not change

4) the aggregate value of resource flows from the stock of natural capital remains intact (because this value is the product of price and quantity used, quantity may decline if prices rise) (Pearce and Turner, 1990:53).

Neoclassical economists have tended to adopt the second of these approaches as an indicator of strong sustainability. At this point, a brief excursion through some controversies in capital theory helps illustrate that even the much less complicated case of defining conditions under which *manufactured* capital stocks are maintained intact, raises a host of difficulties. The "Cambridge controversy" in capital theory arose when neoclassical economists extended one-capital-good models (in which all capital is homogeneous) to the case of heterogeneous capital. In the ensuing debate, it became clear that the neoclassical endeavour to use a scarcity theory of value where price serves as an index of resource scarcity relative to demand, could not be defended analytically (Cohen, 1993:149). It is therefore impossible to construct a price index based on a theoretically rigorous aggregation of heterogeneous capital without extraordinarily restrictive assumptions (Burmeister, 1980:154). This implies that there is no theoretically defensible means of determining whether the stock of manufactured capital is being maintained intact or is being depleted, and hence no means of determining whether current consumption involves manufactured capital maintenance, depletion or investment, and hence whether current consumption is financed by income or through depletion. A further difficulty arises because the neoclassical model contains a circularity: "the quantity of capital depends on its value, its value depends on the rate of interest, and the rate of interest depends on the quantity of capital" (Victor, 1991:205). As a result of these difficulties the notion that prudent economic behaviour requires that one maintain the stock of manufactured (and financial) capital intact has no strict theoretical interpretation.

Beyond theoretical difficulties, there are a number of practical questions to consider as well. Because resource prices reflect marginal valuations, the use of market prices to value total stocks could give precisely the wrong policy signal. If real prices rise faster than resource quantities decline, the value of the stock of natural capital would increase despite impending depletion. Furthermore, marginal prices do not reflect the interests of future generations, nor are they of assistance in pricing non-traded natural capital (Victor, 1991:203).

Defining sustainability as non-declining total value of natural capital stocks can only be a valid indicator of sustainability if the changes in capital stocks are valued on the basis of prices which would be observed in a sustainable time path. (Martinez-Alier and O'Connor, 1996:175). Yet market prices do not reflect environmental externalities, and given that all prices are interrelated, *all* market prices are affected by this omission and would therefore be misleading (Victor et al, 1995:80). Current prices may therefore diverge widely from those that would be observed in a sustainable time path. Furthermore, as pointed out long ago by Lauderdale, as the increase in population and economic growth converts formerly free goods into scarce goods with market prices, the apparent (estimated) value of the total stock of natural capital increases even while its quantity declines (Lauderdale, 1819; Daly 1991:40).

Given the inherent weakness and limitations of any approach which requires valuation of either natural capital stocks or flows, an alternative is required. The ecological economics literature tends to define sustainability in direct bio-physical units or characteristics, which are taken to be constraints within which the economy should operate. Shadow prices can be derived from such constraints which would illustrate the current degree of unsustainability (Victor, 1991:211). Accordingly, this research project will operate on the basis that sustainability must be understood in bio-physical terms.

For the purposes of this research paper, "maintenance of natural capital" will be seen as a metaphorical device, a useful device in exploring the linkages between the economy and the environment. Prudent economic behavior requires that natural capital be maintained intact, that we adopt the popular adage of "living off the interest."

Yet despite such aphorisms, it is important that the maintenance of natural capital be seen in terms which are ecologically, and not economically oriented. For instance, it used to be common in the forest industry to make statements such as, "we plant two trees for every tree we cut," the implication being that the forest stock is being more than maintained. Although measures such as replanting contribute to continued output of timber, they may do little to maintain biodiversity, ecosystem structure, or ecological functions (as will be shown in later sections).

As Victor and others have noted, the concept of natural capital is not without drawbacks. Unlike manufactured capital, natural capital is not reproducible by human action, nor can it be managed in the same way (Victor, 1991:210). Because ecosystems are not static, but continually change and evolve, they differ considerably from manufactured capital. One does not enter a factory each morning expecting to find that the machines will have reorganized themselves, that their numbers and distribution will be different. At the same time, while a manager could redeploy manufactured capital in new ways to vary production processes, we have very limited ability to successfully reorganize natural capital. Contemporary ecology provides limited ecological rationale for maintaining a constant stock of natural capital, though these limitations do not mean that the concept of natural capital need be abandoned for normative purposes (Harte, 1995). Furthermore, even if, to avoid the difficulties involved in aggregating heterogeneous stocks, one avoids using monetary valuation when assessing whether natural capital stocks are being maintained, the biophysical approach raises similar problems. As Hinterberger et al. note (1997:17): "adding oil fields, butterflies, and the functions of the atmosphere and wetlands and 'controlling' these entities--in the sense of keeping them constant--is to our mind, impossible."

In a more radical critique of the natural capital concept, O'Connor (1994) suggests that by representing nature as capital, capitalism provides new legitimacy for itself and extends its hegemony. Nature, formerly external to the capitalist system, is redefined as a stock so as to be incorporated into the market economy, such that a new system of capitalized nature emerges. In this system of capitalized nature, the natural environment and natural resources are to face the self-regulating discipline of the market mechanism, through the delineation of clear property rights. While this facilitates the highest economic use for the different elements of nature so capitalized, it leads to misappropriation, dispossession and cost shifting, a "terrible, abject competitiveness on all counts" (O'Connor, 1994:126). This recalls Polanyi's seminal observation, that "What we call land is an element of nature inextricably interwoven with man's institutions. To isolate it and to form a market out of it was perhaps the weirdest of all undertakings of our ancestors" (Polanyi, 1957 [1944]:178). However, while O'Connor's and Polanyi's warnings are well taken, drawing on the natural capital metaphor to provide societal guidance for economically prudent exploitation of renewable resources does not necessarily imply that the extension of the market is the best or most appropriate means to achieve this goal.

While the limitations of the natural capital metaphor are acknowledged, the approach advocated in this study will be to understand the requirement to maintain natural capital intact in the context of an "ecosystem health," or ecological integrity approach. The intent is to provide for non-declining levels of ecological function and service over time (see generally Costanza, Norton et al., 1992). Accordingly, maintaining natural capital intact will be defined as maintaining ecosystem integrity, biodiversity and a consistent level of ecological function and service, whereby neither renewable resources nor other ecosystem components are perturbed beyond natural boundaries of variation (Mangel et al., 1996). This definition expresses an ideal state. It must be recognized that in a situation where global ecological stresses and deterioration are widespread, there may be no local resource extraction regime that, in a strict sense, is able to maintain natural capital intact. The intent should be to devise extraction regimes which as much as possible are consistent with this goal. The implications of this understanding of the requirements for natural capital maintenance will be addressed in more detail in section 3.5. Thus, the concept of natural capital should not be taken too literally. Applied in an economic mindset, it could be misinterpreted to suggest that humans have unrestricted freedom to dispose of or manipulate nature as humans see fit, that all elements of nature can be owned, or that there is nothing in nature which is of spiritual significance (see generally Lohmann, 1991). Alternatively, it could be interpreted in a way that suggests that no human use of ecosystems is compatible with maintaining natural capital intact. Neither of these extremes is appropriate.

3.3 Societal Commitment to Sustainable Development

Establishing that conventional economic theory and prudent economic behavior suggest an implicit requirement to maintain natural capital intact requires a carefully considered argument. By way of contrast, the link between a societal commitment to sustainable development and the need for strong sustainability is much more direct and intuitive, if it is accepted that such societal commitment exists.

3.3.1 Evidence of a Societal Commitment to Sustainable Development

The term "sustainable development," coined by Barbara Ward (Ward and Dubos, 1972) of the International Institute for Environment and Development, first gained international prominence when the International Union for the Conservation of Nature released its World Conservation Strategy in 1980. The strategy's overall aim was of "achieving sustainable development through the conservation of living resources" (Lélé, 1991:610). The definition advocated by the World Commission on Environment and Development (WCED) is that most commonly referred to by governments and in the sustainable development literature:

> Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987:43).

The report of the WCED became a focal point for discussions on environmental matters around the globe (Dovers and Handmer, 1993:217). Governments, including those of both Canada and British Columbia, committed themselves to sustainable development, as did many businesses and environmental organizations (Jacobs, 1993:59; British Columbia Round Table on the Environment and the Economy, 1992). Within the forestry sector, the Canadian Council of Forest Ministers responded to the call for sustainable development by seeking in 1991 to involve the public in defining principles for the sustainable management of Canada's forests. This effort culminated in the March 1992 Canada Forest Accord, signed by all ministers responsible for forests and by a number of representatives from industry, the IWA, and mainstream NGOs (Canadian Council of Forest Ministers, 1992). The Clayoquot Sound Scientific Panel refers to four documents as evidence of Canada's commitment to the international community to manage Canada's forests' sustainability. The documents are the Framework Convention on Climate Change, the Convention on Biological Diversity, Agenda 21, and Guiding Principles on Forests (Scientific Panel for Sustainable Forest Practises in Clayoquot Sound, 1995a:v).

At the same time, as governments and industry were signing commitments to sustainability, skeptics decried that policies and actions were being labeled as consistent with sustainable development despite clear evidence that they would entail ecological deterioration. Within the sustainability debate, a number of contradictions and tensions are often ignored or downplayed. Society engages in the rhetoric of sustainable development, all the while carrying on with activities inconsistent with a concern for sustainability (Dovers and Handmer, 1993:221). However, the premise upon which this research project proceeds is that support for sustainable development was and is widespread. This support is largely due to three factors: a belief that society has a responsibility to ensure that future generations can enjoy the environment (Jacobs, 1993:60); a consensus that current economic structures are threatening the viability of the biosphere (Ekins, 1992:26); and a concern for intra- and intergenerational equity (Jacobs, 1993:60).

Whether or not governments implement the policies required to achieve sustainability is to a large extent irrelevant to whether sustainability can be taken as a societal objective. The fact that governments have adopted sustainability as an objective as a result of considerable public pressure to do something about the environment suggests that the economic analyst should incorporate this objective into economic analysis. It should be noted that there is no such social consensus, for instance, that projects should be evaluated on the basis of a potential pareto improvement criterion, yet this criterion is widely applied by economists and presented as a societal objective beyond question (Hausman and McPherson, 1996:87-89). Societal commitment to sustainable development has been further reinforced by the adoption of the precautionary principle at the 1992 UN Conference on Environment and Development. This principle affects what is to be understood by "maintaining natural capital intact" in several ways. It imposes a duty on states to take cost-effective actions to prevent serious or irreversible damage to the environment, despite scientific uncertainty as to the causes or consequences of environmental deterioration (Common, 1995:213). It requires the safeguarding of ecological space, a recognition of the need to allow natural processes to function and of the need to redress the accumulated ecological debt (O'Riordan and Cameron, 1994:17-18). The precautionary principle implies that the environment must not be harmed unless the opportunity costs of environmental protection are very high

(Pearce, 1994b:144). Finally, a global commitment to sustainable development is shown by the directive of the Statistical Commission of the United Nations encouraging all countries to supplement their national accounts with environmental satellite accounts, and to calculate a net domestic product series which subtracts depletion and degradation of resource stocks (Lutz, 1993:3-5).

3.3.2 Societal Commitment Despite Unsustainable Market Behaviour

The following objections to the argument that economists should take into account a societal commitment to sustainability can be anticipated. Neoclassical economists adopt as a rule the concept of consumer sovereignty. The individual is assumed to be the best judge of his or her own well-being. To do otherwise is claimed to be paternalistic. (The economist cannot therefore judge the drug addict's purchase of heroin.) Accordingly, economists who take the respect of consumer sovereignty as a fundamental tenet of their profession can point to observed market behaviour to argue that there is no societal commitment to sustainable development. If consumers did desire sustainability, the neoclassical perspective would suggest, the aggregate effect of all market purchases would be sustainable, as informed consumers would not buy products which were incompatible with living within ecological limits. Yet market purchases actually suggest very little concern for sustainability: from airplane tickets to luxury cars, monster homes to pesticides for the lawn, the aggregate impact of western consumer culture is ecologically disastrous (Wackernagel and Rees, 1996:85). If economists restrict their field of inquiry to optimizing the satisfaction of individual preferences, then a societal commitment to sustainability is neither acknowledged nor relevant. The only concern of the economist becomes to propose policies which maximize current welfare regardless of the consequences. Luckily for advocates of sustainability, the argument that economists are restrained by consumer sovereignty from dealing with other social objectives has several significant weaknesses.

Sagoff challenges consumer sovereignty by arguing that individuals act both as consumers and as citizens. In their role as citizens, they may vote to restrain their options as consumers in order to achieve socially desirable outcomes (Sagoff, 1988). Society is more than an aggregate of rational economic agents: individuals are part of families; they require communities (Daly and Cobb, 1994:159; England, 1993; Etzioni, 1988:8-11). Furthermore, individuals are encouraged to consume unsustainably by a massive advertising industry, while public relations companies work on behalf of corporate and government clients to reassure the public that our ecological predicament is under control (Nelson, 1997). Existing institutions and infrastructure make it difficult for individuals to change their behavior on their own. For instance, it is hard to give up one's car when public transit services are inadequate. The perfect information assumed by neoclassical theory is most often not available, and individuals or even corporations and public institutions do not know the ecological impact of their behavior or purchases, nor are they aware of less harmful alternatives, even when existing market conditions make the more sustainable alternative cheaper (Jackson and Jacobs, 1991:57-60). Individuals are also forced into "social traps", where incentives faced by individuals are inconsistent with sustainability (Costanza, 1991:332).

If achieving sustainability were not costly (in terms of foregone consumer benefits), most people would accept the necessary changes. As it becomes clear that sustainability is (at least initially) more costly, many people may not be willing to make the required sacrifices. From this observation, it has been suggested that the demand for sustainability is best represented by a sharply descending demand curve. From this one might conclude that societal commitment to sustainability will evaporate once actual tough decisions must be made. Part of the problem is that the sustainability path is always made to appear as requiring great sacrifices and offering few benefits, other than sustainability itself. To overcome this problem and perception, we must find means of implementing sustainable development in ways that reinforce other social goals, such that more sustainable outcomes are felt to provide greater levels of social benefits (Cohen et al., 1996:167). At the same time, it is misleading to frame the costs of sustainability as forgone economic benefits due to tighter environmental standards, because it suggests that those benefits would have continued indefinitely with status quo policies--in which case sustainability is not an issue.

There are also many opportunities to move toward sustainability which are less costly than the continuation of the status quo (Jackson and Jacobs, 1991:52; Hueting, 1996). Also, the market does not present consumers with a realistic choice with respect to the costs and benefits of sustainable or unsustainable activities. For instance, while IWA loggers currently see the benefits of status quo logging policies (e.g. employment and high wages), they do not see all the long term consequences: impacts of such policies are more widely diffused and can only be vaguely predicted. There are also significant numbers of economically and environmentally marginalised people who are forced to bear the fallout from unsustainable consumer choices, frequently against their will, while obtaining few if any benefits. Amongst them we can count First Nations in Canada whose traditional territories have been damaged by logging, flooding, or mining. There are scores of dispossessed peasants and indigenous peoples throughout the world (Swaney and Olson, 1992:9-17). Indeed, up to 10 000 people are estimated to be dying daily because of deteriorating ecological conditions (O'Riordan and Cameron, 1994:12). Thus, many of those members of the IWA whose income depends upon high rates of resource extraction might well find their generous paychecks less appealing if they were aware of the ecological and social consequences, short and long term, of their jobs and of their lifestyles.

The argument that social goals are only to be seen in market behavior, taken to its logical extreme, would require a wholesale revamping of western societies, and would be fundamentally undemocratic. One does not observe market demand for equality, justice or security, yet there is broad societal consent to constrain the market to respect these values. Sustainability is then a new constraint that society is beginning to impose on the market, in addition to constraints aimed at equality, justice and the like; its importance has only been recently appreciated (Cohen et al., 1996:171; Costanza and Folke, 1997). Furthermore, when economists advocate that observed market behavior is the only source from which societal goals can be determined, they are by implication advocating that current power structures and the given distribution of wealth be accepted as a given. It would leave much of the world's population with no say in how society should be organized; and it would justify proposals which have shocking moral consequences (Hausman and McPherson, 1996:197-199). Furthermore, welfare economists proceed on the basis of identifying potential pareto improvements, yet this criterion has not been socially endorsed and is controversial (Hausman and McPherson, 1996:87-99; Lux and Lutz, 1979:92-101; Sagoff, 1994a:291). If sustainability should not be taken as a societal objective, why should efficiency?

Economists have long resisted recognizing the political element in supposedly objective statements provided from "an economic perspective." Economists are, often unwittingly, involved in a game of hide-and-seek, in which norms are hidden in scientific concepts (Myrdal, 1990 [1954]:192). The quest of economics to increase the general welfare, and the related appeal to concepts such as consumer sovereignty, presumes an implausible harmony of interests and is highly normative. This quest is implicitly based on higher principles that most economists denounce, and is the result of a long series of value-related choices made but not acknowledged by generations of economists (Myrdal, 1990

[1954]:23-24). Deriving such policies, while denying the normative context involved, is a logical fallacy that is "inevitable when economic theory attempts the logically impossible feat of arriving at political conclusions without political premises" (Myrdal, 1990 [1954]:14). Yet economists have long gotten away with this very sleight of hand because they appear to have "*access to a sphere of values which are both objective and observable*" (emphasis in original; Myrdal, 1990[1954]:5). Policies given the cloak of objectivity by reference to economic concepts, even though highly normative, are likely to enjoy currency and legitimacy the more they are biased towards the prevailing social order (Myrdal, 1990 [1954]:31).

Myrdal was much distressed by this hidden political content of economic thought and analysis. His solution to this unfortunate situation was that economic analysis should be preceded by explicitly stated value premises that correspond to real interests within society, as opposed to arbitrary interests incorporated into economic thought through the influence of natural law philosophies and the exigencies of utilitarianism (Myrdal, 1990 [1954]:191-194). The approach advocated in this study is consistent with Myrdal's recommendation. Sustainability is adopted as a value premise that will underlie economic analysis on the basis of public commitments towards sustainable development and commonly accepted notions of responsibility towards future generations. The recognizable interest is therefore those members of society who desire sustainability as well as future generations who will benefit from inheriting a habitable Earth. The analytical methods that follow from such a value premise will have no interest to those who deny any interest in sustainability or the plight of future generations. At the same time, deriving analytical methods entirely consistent with the stated value premise is a difficult undertaking. For economic thought and the tools of economic analysis to purge themselves of the arbitrary norms identified by Myrdal risks bringing about the repudiation of much economic theory and many analytical tools. For instance, at the root of the economist's concept of property "is a definitive idea about man's [sic] place in nature. Man alone is active, nature is passive. Man alone is cause... while external value is only a set of conditions" (Myrdal, 1990 [1954]:72). Rebuilding theory and tools from a normative commitment to sustainability is a complex task, and the approach advocated here is an early hybrid of mainstream economics and an economics of sustainability.

For all the above reasons, the position that economists are constrained by the principle of consumer sovereignty from addressing sustainability is rejected. This is a position which is obviously uncontroversial amongst ecological economists, since they take the desirability of sustainability as a given. It should be noted that Hueting's proposal to calculate ecological costs on the basis that there is a societal commitment to sustainability has been accepted by the Netherlands government and recommended by the Statistical Division of the United Nations as one means of accounting for the depletion of natural capital (Hueting 1991; United Nations 1993:19).

3.3.3 Societal Commitment and Natural Capital

Given this societal commitment to sustainable development, what are the implications for the maintenance of the stock of natural capital? Support for sustainable development, as noted above, is largely due to the belief that we have a responsibility to future generations and that additional deterioration of the biosphere is undesirable and risky.

Natural capital, then, should be maintained in a manner which allows future generations to meet their needs, and in a manner such that continued viability of the biosphere is promoted, not compromised. Norton has proposed that this can be stated as a moral principle: "No generation has a right to destabilize the self-organizing systems that provide the context for all human activity" (Norton, 1992:24). It is clear that a societal commitment to sustainability implies the strong variant of sustainability. Because maintenance of natural capital becomes the fundamental social obligation, withdrawals from the fund of natural capital are acceptable only as long as the fund is not compromised. This leads to a shift in the debate. As Dobell notes in the BC context,

> ...one does not "withdraw" land from the "working forest" for parks or wilderness preservation purposes; those purposes form the starting point, and "withdrawals" from the fund for commercial forestry (or settlement) can be contemplated only when they do not jeopardize the integrity of the overall commitment to sustainability (Dobell, 1993:12).

Victor et al. examine sustainability with reference to the natural sciences, and conclude that conditions must be imposed on the state of natural capital as it is transferred from one generation to the next. Economics must be induced to respect a set of biophysical constraints, derived by reference to both biophysical and social sciences (Victor et al., 1995:91).

Such positions contrast with that of neoclassical economists such as Solow, who argues that we don't know what future generations will do, what they will want, and what technologies they will have. The only responsibility is to pass on the capacity to be equally well off, to enjoy similar levels of utility (Solow, 1993:181-187). As natural capital declines, people learn to get more enjoyment out of manufactured capital, which Daly labels the "Disneyland effect". Solow's proposal combines both technological substitution, whose weaknesses were documented earlier, with psychological substitution, into something indefinable: discounted future, aggregate utility (Daly, 1992b:251). Furthermore, despite Solow's assertions, we can be reasonably certain in predicting many of the needs of future generations, as many needs such as food, water, shelter, and environmental life support, do not change much over time (Max-Neef, 1992:203-204). Given the highly uncertain prospects that manufactured capital and technological innovation will be effective at reducing the need for natural resource flows and ecosystem services, it is prudent to conclude then that future generations are likely to desire at least as high a degree of enjoyment of environmental functions and services as the current generation (Jacob, 1993:72).

A sustainable society involves both ecological and social sustainability. Sustainability does not impose the requirement of maintaining a system in its current form, but rather that of maintaining or increasing the resilience of the system's characteristics. Ecological sustainability therefore requires protection of life support systems and maintenance of biotic diversity in all its facets; it requires that resource management regimes maintain or enhance the integrity of ecosystems (Robinson et al., 1990). Participants in a US EPA workshop on ecosystem health concluded that an ecosystem could be considered sustainable "if it is active and maintains its organization and autonomy over time and is resilient to stress" (Haskell et al., 1992:9). A meeting of influential economists and natural scientists resulted in a consensus article declaring economic activities to be sustainable "only if the life-support systems on which they depend are resilient" (Arrow et al., 1995:93). Given the current global level of ecological distress (Union of Concerned Scientists, 1992), and that humans already appropriate approximately 40% of the products of terrestrial photosynthesis (Vitousek et al., 1986), further deterioration in natural systems is inconsistent with sustainable development.

Even passing on current levels of natural capital to future generations may not be satisfactory. If humanity managed, miraculously, to stop overnight all further habitat loss, and to stop all further contamination of the biosphere, ecological deterioration would still continue for centuries. Many species are doomed to extinction, their populations too small for sufficient genetic diversity. One extinction leads to others: the current tide of extinctions could take 50 000 years to play itself out (Norton, 1987). Contamination of the biosphere by persistent hormone-disrupting chemicals threatens the sexual, neurological and behavioural development of fish, amphibians, reptiles, birds and mammals (Alleva et al., 1995). Therefore, sustainable development may require that we pass on to future generations higher than current levels of natural capital by undertaking urgently needed ecological restoration (Jacob, 1993:74).

For the purposes of this research project, it will be assumed that sustainable development requires the preservation of natural capital at present levels (Costanza and Daly, 1992b), as this is the simplest case for the purposes of analysis. This assumption is predicated on a further, and likely unrealistic assumption that there are actions which humanity could take to forestall further declines in natural capital, or in other words, that we have not already gone beyond some limits which will involve irreversible ecological deterioration. Also, in accepting the constant natural capital rule it is essential to interpret this rule with an understanding of the dynamic nature of renewable resources, the existence of uncertainties about environmental conditions, the complexity of interactions between resources and activities, and the variety of uses for a given resource (Lélé, 1991:615).

3.4 Historical Perspectives on the Sustainability of BC's Forest-Dependent Economy

It is also relevant to consider how the distinction between capital and income has arisen in past discussions of BC's forest industry. As early as the 1910 Royal Commission of Inquiry on Timber and Forestry, concerns were expressed that BC forest policies were allowing the natural capital of the forests to be liquidated. The commissioners argued in their final report,

> It is a well established principle of modern business that the capital of any undertaking should be adequate... and your Commissioners feel that it will be wise to adopt the best business principles in dealing with the natural resources that represent so large a percentage of the capital or assets of the Province.
>
> Your Commissioners regard the income from royalty on timber as differing essentially from any other form of revenue in the Province.

> Such receipts should be regarded as capital--not as current revenue (Royal Commission of Inquiry, 1910:D72).

The basis for the Commissioners' recommendation was their concern that timber revenues were based on liquidation, and that the viability of "natural re-afforestation" was still unknown under conditions in BC. The only policy that could ensure a lumber supply and increasing forest revenue for future generations, was one where proceeds were treated as capital and reinvested in the forest stock (Royal Commission of Inquiry, 1910:D71).

In the next public inquiry into BC's forest resources, similar concerns were again expressed. The Commissioner, Chief Justice Sloan, argued,

> Our forest industries have been living on an expenditure of forest capital that has taken hundreds of years to accumulate at no cost to industry. The time has now come when we have to plan to live on forest interest and leave our capital unimpaired (Sloan, 1945:Q128).

Sloan's vision, while definitely timber-oriented, went beyond this narrow principle to encompass a larger social and ecological perspective. He noted that forests had to also provide for the "invaluable functions of watershed protection, stream-flow and run-off control, the prevention of soil erosion, and of providing recreational and scenic areas, and a home for our wild bird and animal life" (Sloan, 1945:Q128).

In 1956, Sloan reported the results of his second public inquiry into BC's forest resources. Ironically, he seemed satisfied that his recommendation to move from treating the forest as a mine to be exhausted, to a renewable resource requiring careful stewardship, had been heeded, despite noting that the provincial cut had increased by 100% in the intervening 10 years (Sloan, 1956:3). The important point, though, is that Sloan once again endorsed the principle of maintaining the forest capital intact.

Outside of official circles, similar ideas were finding expression, in even more urgent forms. In 1940, Colin Cameron, a CCF member of the BC legislative assembly, wrote in a pamphlet on forestry,

> British Columbia has been conducting her affairs like an exiled Russian Grand Duchess who sells her jewels bit by bit to get the more prosaic but more useful necessities of life. And like the Grand Duchess we are rapidly getting down to the last necklace (cited in Wilson, 1986:15).

In his 1944 brief to the Sloan inquiry, Cameron added,

> Is there not a danger that we might find the immature new forest thrown back on our hands when the mature timber which must be the source of funds for its care has been dissipated? (cited in Wilson, 1986:16).

Observers from outside of BC had also noted the liquidation of the province's forests was inconsistent with sound economics. The Royal Commission on Dominion-Provincial Relations argued that BC had managed to provide a high income and standard of living for its population by exploiting virgin resources of above average quality, a state of affairs which would leave the province vulnerable; words which in the late 90s now seem prophetic:

> Overhead government costs that are easily borne from the surplus of above-average resources...may prove crushing when only average resources remain... Services and a standard of living established and financed by treating capital depletion as current income will be subject to extreme pressures when the first phase of exploitation passes. Major economic and social adjustments will be necessary... in no other province are the problems of depreciation and depletion as important to the provincial economy and public finance (Royal Commission on Dominion-Provincial Relations, 1940: Book II, p. 105).

It is clear then that the need to maintain the natural capital of the forest intact has been acknowledged in the BC context since at least 1910. It has also long been recognized that there is a danger in provincial finances, and the provincial economy in general, being dependent on the liquidation of a capital asset. These early insights lacked ecological sophistication, being premissed on the view that, so long as never ending crops of trees matured in time to provide a constant level of harvest, the forest capital could be considered intact. Also, despite frequent assertions that the forest industry was now based on sustained yield management, the annual allowable cut continued to increase as the century progressed. Quickly liquidating old growth so as to more quickly replace these "decadent" forests with a "normal," plantation forest was official government policy. Government acknowledged that this meant that extraction rates would be temporarily inflated, and that a fall down would later be necessary, once the industry was constrained by the exhaustion of old growth, to live off the annual growth of the working forest. The thought was that a scientifically-managed forest would provide more annual growth than wild forests, and hence converting the forest from wild stands to plantations involved capital investment. However, it is clear that the economic insight that forest capital must be maintained intact has long been recognized, even if it has never been applied in a perspective that acknowledged the complexity of forest ecosystems. For this insight to be usefully applied to the forest, it must benefit from recent ecological knowledge.

It is clear then that both conservative and long-noted tenets of economics, and the more recent societal commitment to sustainable development, implies that proper accounting practise should be based on maintaining natural capital intact. Before exploring how economic analysis should do this in chapter four, it is essential to spell out what maintaining natural capital implies in resource management terms, specifically as applied to the forests. This will be the task of the next section.

3.5 What Does It Mean to Maintain the Natural Capital of the Forest Intact?

Daly proposes that maintaining natural capital intact requires that renewable resources not be exploited to extinction, and that harvesting rates not exceed regeneration rates (Daly, 1991:45). He elsewhere adds that the "takeover" of the habitats of other species must be limited (Daly, 1992b:221). While such principles are useful, they are not sufficient. They do not address fragmentation, disturbance regimes, landscape connectivity, or the maintenance of biodiversity. Furthermore, maximum sustained yield policies, which are not inconsistent with Daly's rules, have been shown to encourage unsustainable harvesting of fisheries resources (Ludwig et al., 1993; Clark, 1990:1-13), and, in the BC forestry sector, to be unquestionably in conflict with sustainable development (Haley and Luckert, 1996:58).

A useful approach to identifying the requirements of sustainability has been put forth by the Natural Step Foundation in Sweden (Holmberg et al., 1996:17-48). Because of the difficulty or indeed impossibility of establishing cause-effect relationships in complex ecological systems, it is more useful "...to move the focus early in the causal chain--from studying effects [of contaminants and other environmental stressors] in nature to studying what constraints have to be put on the societal metabolism to avoid any systematic increases of society's impact on nature" (Holmberg et al., 1996:18). This is done by referring to physics, chemistry, biology and ecology to identify fundamental principles which economic activity must not violate if the viability of the ecosphere is to be sustained. Proponents of the Natural Step approach argue that one of four fundamental principles of achieving sustainability is that "the physical conditions for production and diversity within the ecosphere must not be systematically deteriorated." Respecting this requires maintenance of high biodiversity (genetic, species and ecosystem diversity), as well as requiring that harvest rates be less than regeneration rates (Holmberg et al., 1996:27). The important lesson here is that one does not continue with status quo resource management policies until cause-effect relationships are established and ecological deterioration is extensive. Rather, one designs resource management regimes which *a priori* have a good chance of protecting ecological productivity, integrity, and diversity because they respect certain fundamental principles. To design such resource management regimes, one must turn, in the case of forestry, to forest ecology, conservation biology and landscape ecology.

It is now generally accepted in the conservation biology literature that preservation of biodiversity cannot be undertaken at the species level. A landscape approach is required. While natural and provincial parks and ecological reserves contribute to preserving biodiversity, they are inadequate to guarantee maintenance of biodiversity (Franklin, 1993:204; Hansen et al., 1991). Indeed, recent research on extinctions within large North American National Parks shows that the nature preserve approach is inadequate. Many species have become extinct since the parks were established because land adjacent to them has been modified, leading the parks to become functionally insular, but without an adequate land base to sustain many species (Newmark, 1995). The unreserved, or manipulated part of the landscape now dominates North America, occupies the most productive locales, and contains the majority of biological diversity (Pimmental et al., 1992). This unreserved landscape must be managed using prescriptions which retain essential habitat features, structures, processes, and which involve less-intensive manipulations than are currently practiced. If reserves are to be ecologically functional, the unreserved landscape matrix cannot be highly dissimilar to the reserves. This is important not only to conserve biodiversity, but also to maintain forest productivity (Franklin, 1993:204). The Scientific Panel for Sustainable Forest Practices in Clayoquot Sound (1995b) reiterated the need to manage forests on an ecosystem basis in BC. The intent is "to maintain the functional integrity of ecosystems, recognizing the connections between terrestrial, freshwater and marine ecosystems."

Setting aside protected areas while converting the rest of the landscape into highly artificial, intensively managed ecosystems, with other areas subject to relatively weak guidelines, will therefore not protect biodiversity or ecosystem integrity. This protected areas approach, currently prevalent in BC, is incompatible with sustainable development and with maintaining natural capital intact. While protected areas have an important role to play in maintaining biodiversity and ecological integrity, establishing protected areas does not give one the license to significantly manipulate the remainder of the landscape. Forest ecosystem analysis has allowed forest ecologists to identify new approaches to forest management which aim to sustain biological diversity and ecosystem productivity. This research has emphasized the need to move from management by species or for a given commodity to managing the entire forest landscape in order to maintain water quality and fish habitat (Rowland et al., 1993:9), to maintain connections between habitats, and to provide a buffer against uncertainties such as climate change (Swanson and Franklin, 1992:271).

A landscape ecology approach informs forestry by forcing management of the landscape mosaic and of the long-term changes in this mosaic on larger temporal and spatial scales. It also requires that management address the cumulative effects of timber extraction, road building and other intrusions into the forest (Franklin, 1992:37). A landscape approach has the advantage of maintaining stable employment levels and producing a stable output of timber products, as well as higher quality timber (Oliver, 1992:23). The World Resources Institute's guidelines for bioregional management require that landscapes be managed in regions large enough to ensure that their ecological viability is maintained over the long term by sustaining the integrity of ecosystem functions and processes. Each region requires a system of core wildland sites, linked by corridors of natural cover, embedded in a matrix of mixed land cover. When the viability of habitat or ecological functions depends on ecological restoration, such restoration is required (Miller, 1996:8-9).

The technical committee for Canada's model forest program concluded that the *lower* limit for landscape level forest planning should be set at 100 000 hectares, with a more appropriate size being 300 000 ha. Such landscape level plans need to fit into larger, regional ecosystem-based plans (Stan Rowe, personal communication, August 15, 1997). Grumbine argues that ensuring "sustainable landscapes" to sustain biodiversity requires four general ecosystem management goals for forestry:

1. Protect enough habitat for viable populations of all native species in a given landscape;
2. Manage at a regional scale large enough to accommodate natural disturbance processes (fire, wind, climate change, etc.);
3. Plan over a timeline of centuries so that species and ecosystems may continue to evolve; and
4. Allow for human use and occupancy at levels that do not result in ecological degradation (Grumbine, 1993:256).

A prominent committee from the Ecological Society of America was recently delegated the task of setting out the scientific basis for ecosystem management. The committee defines ecosystem management as focussed on maintaining "ecological interactions and processes necessary to sustain ecosystem structure and function." Managers must address long term sustainability; base management on sound ecological models; take complexity and connectivity between ecosystem components into account; acknowledge uncertainty and include a safety factor in resource extraction regimes to adjust for unlikely or unanticipated events; recognize the dynamic nature of ecosystems; and monitor ecosystem character conditions and adapt management regimes as necessary. Sustainability is the primary objective, and levels of commodity production must be adjusted to ensure the goal of sustainability is met. Ecosystem management must maintain biological diversity as a critical component in ensuring that ecosystems remain resilient in the face of disturbance (Christensen et al., 1996). In the report of a recent workshop to update the set of principles for the conservation of wild living resources devised by Holt and Talbot (1978), the participants set out a series of principles and mechanisms to conserve biological diversity. Their second principle stresses the maintenance of biological diversity, at genetic, species, population and ecosystem levels, and recommends that neither desired resources nor other ecosystem components should be stressed beyond natural boundaries of variation. Several mechanisms are set out to achieve this goal. Of importance to the current study:

- manage the total impact on ecosystems and preserve essential ecosystem features;
- identify areas, species and processes that are particularly important, and make special efforts to protect them;
- do not further fragment natural areas;
- maintain or mimic patterns of natural processes;
- avoid disruptions of the food web;
- avoid significant genetic alteration of populations; and
- take into account critical thresholds, synergisms and the lags before effects are manifested (Mangel et al., 1996).

There is thus a consensus within the conservation biology literature that ecosystem-based management is essential and that a landscape level approach is required.

If we do not move to landscape level approaches our prospects may be grim. Due to landscape fragmentation, many plant and animal communities have been subdivided to the point where they are no longer internally viable. The continued existence of such communities depends on continued immigration of individuals from larger, natural core areas. Landscape connections necessary for such immigration have been or are being destroyed, a situation which threatens the long-term viability of the Earth's support system (Jansson and Jansson, 1994:88).

Moving from the landscape level to the stand level, recent ecological research points to the importance of retaining the forest's ecological structure: live trees, snags, and large woody debris. Maintaining structure is of particular importance in riparian areas. Large trees provide bank stability by reducing erosion into the stream. They also provide small organic debris and maintain cool stream temperatures with their shade. Large woody debris improves fish habitat by changing stream morphology and increasing pool areas, and provides nutrients as it decays. Snags in riparian areas and elsewhere in forests also provide habitat to cavity excavators, and places to perch (Johnson, 1997).

Retaining these structures on a site where timber has been extracted contributes to sustaining biological diversity, site productivity, hydrological regimes, stability of predator-prey relationships, and the viability and stability of the soil (Swanson and Franklin, 1992:265). Managed forests have been found to have much lower levels of lichens and insects than their natural counterparts, resulting in lower bird populations and decreased resilience of forest stands to insect infestations (Pettersson et al., 1995). Other studies have shown significantly lower levels of both bird and amphibian populations and species in managed vs. natural forests (Hansen et al., 1991:387). Many salmon and trout stocks are threatened due to logging. Old growth forests provide for salmon habitat by shading the water and moderating temperatures, by providing large woody debris which creates pools where migrating adults can rest and juveniles can take refuge from floods. and by ensuring soil stability (Rowland et al., 1993:2).

Recent research is also showing how patterns of natural disturbance leave the forest with a rich legacy of structural complexity, essential for ecosystem productivity, not found in managed forests. This legacy includes large trees, snags, and fallen trees. This structural complexity provides for plant and animal diversity that managed forests are unable to support (Hansen et al., 1991:389). In reviewing the differences between natural forests and tree plantations in the Pacific Northwest, Norse concluded that the two differed "markedly in species composition, structure and ecosystem functioning...old-growth forests are messy, complex and wild. In contrast, tree plantations are as neat, simple and tame as cornfields" (Dr. Elliot Norse, cited in Rowland et al., 1993:2). Modeling of continued rotations of industrial forestry practices shows how some structural elements, such as coarse woody debris, are expected to decline dramatically after the second harvest (Hansen et al., 1991:387). While nutrient losses in undisturbed forests are typically quite small, timber extraction directly removes nutrients and can significantly speed the rate of nutrient loss from clearcut stands (Perry and Maghembe, 1989:127, Hornbeck and Swank, 1992:241). Sustainability requires that timber managers accept initially lower production of commercial products for increased resilience and viability of ecosystems, more stable productivity over the very long term, and a wider variety of outputs from the forest (Perry and Maghembe, 1989:136; Rowland et al, 1993:15).

While estimates of the Long Run Sustained Yield (LRSY) were used as one of the inputs in setting the Annual Allowable Cut in BC, more recent scientific evidence suggests that yields predicted for managed plantations are unlikely to be attained because of ecological feedbacks. Forest plantations managed on a sustained yield basis in Europe have experienced dramatic drops in productivity by the third rotation, often to the point where the plantation fails completely (Maser, 1988). Predictions of plantation growth rates are largely based on current site productivity, and therefore do not take into account how degradation induced by industrial forestry may reduce future site productivity (Vogt et al., 1989). The short rotations envisioned under maximum sustained yield management fail to replenish the supply of coarse woody debris, reducing invertebrate diversity and likely productivity (Spies and Cline, 1989). Frequent removals of timber on short rotations result in net depletion of organic matter and nutrients (Perry, 1988). Current emphasis on replanting high densities in order to achieve complete canopy closure may threaten the recovery of understory species dependent on ground environments common in old growth stands, and the short rotation ages which preclude forest stands from reaching old growth status may result in long term loss of species diversity (Halpern and Spies, 1995:930). Industrial forestry results in soil compaction, reduced infiltration, increased landslide activity, increased sedimentation of streams, detrimental changes in microclimate, the elimination of beneficial soil organisms, and decreased rates of nitrogen fixation (Hammond and Hammond, n.d., pp. 7.4-7.7; Ministry of Forests and Forestry Canada, 1992). These stresses on soil can lead to reduced site productivity and plantation failures (Utzig and Walmsley, 1988; Harvey et al., 1989; Ministry of Forests, 1987). Plantation forestry results in monocultures and near monocultures, reduced genetic variability, and reduced resilience in the face of natural or human-induced stresses such as disease, insect infestation or climate change (Maser, 1988:90-92). Fire-fighting efforts designed to protect timber supplies have dramatically reduced wildfire, once one of the most important natural disturbances and an integral part of the ecological process in interior and northern forests (Gast et al., 1991).

When factors reducing site productivity are combined with the impairment of landscape level functioning, changes in disturbance regimes, reductions in natural habitat, and declines in genetic and species diversity due to industrial forestry, overall productivity of the managed forest landscape is likely to be considerably reduced over that shown in conventional forestry projections (Maser, 1988). Furthermore, the ability of intensively managed ecosystems to produce resources for extended time frames is highly dependent on the matrix of less managed landscapes within which managed ecosystems are embedded (Christensen et al., 1996:667), yet these more natural landscapes are increasingly scarce. If forest managers are determined to maintain the timber productivity of plantations despite ecological stresses, extensive inputs of fertilizers, biocides, human labour and mechanical power will be required (Lansky, 1992:106-115). These inputs will draw down natural capital elsewhere by requiring fossil fuel inputs and causing ecological degradation. The phenomenon of having to increase external inputs to maintain continued production of one or two desired commodities, at the same time as ecosystem health deteriorates, has been observed across the board in Holling's review of 23 ecosystems managed for narrow societal objectives. In each case,

> the very success of management seemed to set the condition for collapse.... Success in managing a target variable for production of food or fibre apparently leads to an ultimate pathology of (1) more brittle and vulnerable ecosystems, (2) more rigid and unresponsive management agencies, and (3) more dependent societies (Holling, 1994:68).

Compensating for declines in ecological functions in order to maintain fibre flows by relying extensively on external inputs cannot be taken to be consistent with maintaining natural capital intact.

While the intent of conventional, scientific forestry appeared superficially, until recent ecological insights, to be consistent with the requirement of maintaining natural capital intact, Maser suggests that scientific forestry's reliance on soil-rent theory made it incompatible with sustainability from its very origins. Soil-rent theory contains six flawed assumptions, including "that the depth and fertility of the soil in which the forest grows is an ecological constant" and "that biodiversity is an ecological constant" (Maser, 1993:267).

From this brief review, it is apparent that maintaining the natural capital of the forest requires the following: i) a landscape ecology approach must be adopted; ii) managed forests must contain the same structures and legacies as their natural counterparts; iii) managed forests must not "contrast" with natural forests significantly; iv) timber extraction rates must be cautiously set at levels well below the annual increment so as to provide a safety factor in the face of uncertainty and natural variability; v) soil productivity must be maintained; and vi) species, genetic and habitat diversity must be maintained. Any forest use which significantly diverges from these conditions risks consuming or degrading natural capital, and the proceeds from such activity will need to be adjusted accordingly to reflect the fact that it does not represent living off income, but rather consumption of natural capital.

While this section has drawn on the evolving concept of ecosystem management to identify the requirements of maintaining natural capital intact, caution is required, as there are signs that this concept is being co-opted. Ecosystem management was originally intended by its progenitors to be interpreted as a management approach focussed on maintaining ecosystem integrity over the long term, with resource extraction constrained by this primary objective. Reinterpretations of the ecosystem management concept by corporate interests have resisted displacing the conventional emphasis on commodity production as the primary objective. and have limited their accommodation to the need for the maintenance of ecosystem integrity to the acceptance of moderate ecosystem constraints. At the same time, existing management practices are left unchanged but are relabelled to fit ecosystem management vocabulary (Burda et al., 1997:7; Stanley, 1995:256; Grumbine, 1994:32; see for instance Thomas, 1996, or Canadian Standards Association, 1996). While this latter, more diluted understanding of ecosystem management may prove more palatable to those who benefit from high rates of resource extraction, as it does not involve radical departures from the status quo, it does not ensure that natural capital is maintained intact.

3.6 Ecosystem-Based Planning: Identifying Natural Capital Constraints

3.6.1 Silva Forest Foundation's Approach to Ecosystem-Based Planning

Frustrated and alarmed by the growing evidence of the negative social and ecological consequences of industrial forestry, forester and forest ecologist Herb Hammond sought to blend wisdom and intuition with science to develop a new approach to forestry, which he labelled wholistic forest use (Hammond, 1991:9). Fundamental to wholistic forest use is the preparation of ecosystem-based landscape plans which aim to protect biodiversity and ecosystem functioning at the landscape level. These plans are intended to create a protected landscape network, which locates and protects the most sensitive ecosystems, and to integrate human requirements into the forest landscape in a way that maintains the ecological integrity of the forest (Hammond, 1991:220-228). Within stands identified as ecologically appropriate for timber extraction, harvesting is carried out in accordance with ecoforestry principles (Hammond, 1997; Hammond, 1991:226). Hammond does not claim to have the answer to sustainable forest management; rather, he sees wholistic forest use as a learning process, where the community has the responsibility to observe, learn and incorporate new ecological knowledge, always with the intention of sustaining the forest (Hammond, 1991:254). The approach advocated by Hammond parallels the development of "new" forestry or ecoforestry, and recent efforts to develop ecocertification standards (see, for instance, the Journal of Ecoforestry; Global Biodiversity, Fall 1997 issue; Drengson and Taylor, 1997; M'Gonigle and Parfitt, 1994; Pacific Certification Council, 1996).

Hammond et al., explain that the ecosystem-based approach advocated by the Silva Forest Foundation draws upon forest ecology, conservation biology, landscape ecology and ecological economics (1996: Chapter 2, p. 18). Landscape ecology points to the need for appropriate levels of landscape heterogeneity, allowing processes to occur at different spatial and temporal scales, which ensures redundancy in the landscape by allowing ecosystem functions to be carried out by more than one process. This redundancy imparts resiliency to ecosystems in the face of stress or catastrophic disturbances (Walker, 1995). Landscape ecology also emphasizes the need for landscape connectivity. Ecosystem-based plans address connectivity through permanent corridors designed to allow movement of animals and to provide representation of the full spectrum of habitats from valley-bottom to alpine areas. These corridors are often associated with riparian zones, but also include treed, cross-valley corridors. Conservation biology provides the rationale for preserving biodiversity and the knowledge to stem the loss of biodiversity. Finally, ecological economics provides a new approach to analyzing the implications of forest management decisions in a way that is more cognizant of the relationship between ecosystems and economics (Hammond et al., 1996: Chapter 2, Section 8).

The Silva Forest Foundation (SFF) has prepared an ecosystem-based plan for the Slocan Valley Watershed in the Kootenays of BC. SFF is also in the process of preparing ecosystem-based plans for three regions of BC-- Cortez Island, the Robson Valley, and Harrop Proctor--as well as Nitassinan (the traditional territory of the Innu on the Quebec-Labrador peninsula). In addition, Silva is assisting communities in Washington State, Indonesia, and Siberia to prepare their own ecosystem-based plans (Hammond, Susan, 1997:9). Silva's methodology was presented at the Third International Conference of Ecological Economics in Costa Rica in 1994 (Hammond et al., 1994). Thus, while the Silva approach has yet to be adopted by any forestry department, it is receiving much attention and attracting interest and support at the community level.

Silva begins an ecosystem-based plan by conducting landscape analysis to understand the characteristics and conditions of the landscape unit in question. This analysis aims to incorporate the local ecological knowledge of indigenous peoples and other residents. These landscape characteristics bear upon the ecosystem functions and patterns over space and time, in order to identify essential composition and structures necessary to maintain ecosystem functioning. The condition of the landscape reflects how past and current landscape use has influenced the landscape and ecological functions, through forest fragmentation, soil erosion, and human settlement (Hammond et al., 1996: Chapter 3, p.

9). Ecological limits due to steep slopes, slope complexity, soil depth, and soil moisture are located and incorporated into constraint maps (Hammond et al., 1996: Chapter 4, p. 11). Using a Geographical Information System (GIS), maps are prepared which identify past cutting, remaining old growth, ecological sensitivity to disturbance, and other constraints on land use. GIS is also used to help design a protected landscape network to maintain landscape connectivity, and to protect biodiversity and ecological functions.

The protected landscape network includes riparian areas, ecologically sensitive sites, cross-valley corridors and old-growth nodes. In landscapes where old growth has been liquidated, old growth recruitment reserves are set aside; where extensive ecological degradation has taken place, ecological restoration zones are identified. Those restoration zones which are on appropriate terrain may eventually be included as part of the timber producing landscape, allowing for the ecologically sustainable allowable cut to increase once restoration is satisfactory (Hammond et al., 1996: Chapter 4, p. 16). Human use zones are identified, including aboriginal land use, consumptive use watersheds, headwater protection zones, and commercial tourism zones. Identifying human use zones involves extensive community consultations. Finally, in the remaining, unallocated landscape, wholistic timber zones are identified on stable and moderately stable terrain. Limited amounts of timber cutting may be permitted in the other zones, under appropriate conditions, so long as the cutting and related activities do not compromise or impair the zone's contribution to the landscape, or interfere with the provision of other ecological services.

Silva calculates the annual allowable cut by analyzing stand level data for timber zones and by assessing timber availability from other zones. This analysis is carried out at the small watershed level. Timber available for human extraction within timber zones is constrained by reserving 25% of the yield in large trees which are left to grow old and die; individual cuts never remove more than 15% of the trees in a stand, and entries are separated by 15 years or more (Hammond et al., 1996: Chapter 4, p. 22). Often, tighter restrictions are imposed.

The Silva ecosystem-based planning approach can be seen as attempting to cautiously define the conditions under which natural capital is maintained intact. If forestry activities are carried out within the identified constraints, landscape level ecosystem functions and integrity should be maintained. At the stand level, ecological legacies will be maintained. While Silva's approach has not yet been subjected to an extensive peer review, it parallels proposals which have been emerging around the globe. For instance, UNESCO Biosphere reserves typically involve core protected areas and surrounding lands with compatible human uses. The Wildlands Project, which seeks to protect and restore the ecological richness and native diversity of North America, is also based on identifying and protecting ecologically sensitive areas, core preserves, and corridors, and then integrating human activity into the remaining landscape. The Wildlands Project is, however, considerably *more* ecologically cautious than the Silva approach (see generally Noss, 1992).

3.6.2 Criticisms of the Silva Forest Foundation's Approach

The Silva approach has not been without its critics. The BC Ministry of Forests released part of its review of Silva's plan for the Slocan Valley, which included comments on the ecological aspects of the Silva plan. While agreeing "in large part with the basic notions advanced in the report," and expressing sympathy for the need to provide greater protection of resources than is currently available, the ministry's report (written by a forester who is also a biologist) suggests that the report contains a number of scientific inaccuracies and concludes that the Silva approach is excessively cautious. Human activities under the Silva plan would be "so limited that any negative impacts on the ecosystem from human activities are highly unlikely." The report argues that Silva is overly risk-averse largely because there is no recognition that ecological redundancy allows ecosystems to withstand a fair amount of human manipulation. The plan has "used the precautionary principle more conservatively than I've seen anywhere else where resource use is intended as part of the package" (Kremsater, 1996:13). Despite these criticisms, the reviewer concludes, "the report represents a large amount of work and the underlying principles are generally (aside from the exceptions noted) well-founded in the (fuzzy) field of conservation biology" (Kremsater, 1996:14).

I make no claims of being able to judge whether the Silva Forest Foundation's plan is indeed excessively cautious, or to what extent the science behind the report is appropriately applied; and indeed, such judgment is not necessary to achieve the purposes of the present research study. It may well be that certain requirements of the Silva plan could be relaxed. Perhaps cross-valley corridors could be less numerous, riparian zones could be narrower, perhaps more high-altitude or dry sites could be designated as timber zones, perhaps a smaller proportion of trees need to be set aside on a stand to grow old and die, or perhaps the rotation age could be shortened by a couple of decades. Making such changes would indeed increase the AAC. Then again, perhaps research and experience would reveal that the Silva requirements need to be tightened, in which case the AAC estimated by Silva would need to be reduced. Such judgments, because of the uncertainties involved in understanding and predicting human influences on ecosystem functioning, and because of the human values involved, involve the application of "postnormal science". Review of such matters needs to be made by an extended peer community (Funtowicz and Ravetz, 1991). However, as part of my training to gain competency in ecological economics, my education has included courses in the natural sciences and ecology. While I do not have competency to judge the particulars of the SFF approach, the overall methodology appears to be well considered as a means to identify human constraints on the manipulation of forest ecosystems and the extraction of commodities from the forest. It provides an indication of the likely magnitude of reductions of extraction levels which must be implemented if we are indeed intent on sustainability. The differences between status quo and SFF projections of sustainable timber yields are large enough that even if it turns out that several adjustments to the SFF methods are required, such that permitted extraction rates could rise (or fall), the remaining difference between SFF's projections and the Ministry's will be large enough to sustain the research agenda of this study. It therefore provides a promising case study to examine how economic analysis might be modified to incorporate strong sustainability. It also has the support of respected forest ecologists such as Dr. Stan Rowe (Rowe, 1997a, b). It should be recalled that the intent of this research project is not to determine the AAC for the Slocan Valley, but rather to illustrate how economic analysis should take into account the proceeds derived from the depletion of natural capital.

3.6.3 Do Reforms of BC Forest Practices Ensure that Natural Capital is Maintained Intact?

A review of the Silva Ecosystem-based Plan for the Slocan Valley by the Economics and Trade Branch of the Ministry of Forests challenged the plan's conclusions that current management practices would lead to significant ecological deterioration. Silva's conclusions suggest "that the many changes in land use and forest management practices that have occurred and are occurring in British Columbia will not address many of the concerns with regard to preservation of environmental quality" (Economics and Trade Branch, 1996:3). The report then challenges this view, citing the Forest Practices Code, the Protected Area Strategy, the Commission on Resources and Environment Planning Process, the Timber Supply Review Process and other such initiatives.

There is no doubt that some of these initiatives will at least slow the rate of ecological deterioration, but there is little reason to believe that they will ensure that the natural capital of the forest will be maintained intact. For instance, a review of the first 18 months following the implementation of the Forest Practices Code revealed that clearcutting was the silvicultural system for 92% of new cutblocks (Sierra Legal Defense Fund, 1996). Despite the Code, clearcuts were being approved on high-risk slopes, small forest streams were being clearcut right to the banks, cutblocks were often double the permitted size, no court charges have ever been laid, wildlife and biodiversity provisions have not been implemented, and the provincial AAC has actually increased by 1% (Sierra Legal Defense Fund, 1996a, b). A review of BC management of terrain stability risks concluded that there was "failure to rigorously enforce terrain provisions of the Code, and cynical evasion of the law by government and industry in the face of known hazards that will lead to an increased prevalence of future landslides..." (Sierra Legal Defense Fund, 1997a:24). A review of wildlife, endangered species and biodiversity protection under the Code concludes that,

> ...the Ministry of Forests is stonewalling to avoid protecting wildlife... Province-wide, the impacts of all aspects of the Code [on reducing the AAC] are limited to a maximum of 6%... The disturbing reality is that none of the Code's five new mechanisms for protecting wildlife, endangered species and biodiversity has protected a single hectare of land in BC, twenty-one months after the Code became law (Sierra Legal Defense Fund, 1997b:3).

There is much evidence that the reforms in BC's forest practices are more cosmetic than ecologically significant, and indeed are designed to forestall a reduction in the AAC. Government refuses to challenge industry or the unions. Without significant reductions in the AAC, changes in tenure, logging systems, and forest service priorities, there is no reason to believe that the reforms are ecologically motivated, nor that they will be effective (Burda et al, 1997:27; Greenpeace, 1997; Smith, 1997; Sierra Club of BC, 1997). Clearly, government laws and standards and current practice are severely degrading BC's natural capital and are inconsistent with the requirements of strong sustainability.

Chapter 4: Critique of Economic Analysis of Forest Land Use Allocation

4.1 Chapter Overview

In recent years, largely as a result of increasingly contentious struggles over forest management decisions, the government of BC has produced numerous economic studies to evaluate various forest land use and timber extraction decisions. In particular, since 1992, Multiple Accounts Analysis (MAA) has become the technique of choice for the Ministry of Forests and the government of BC. According to the Ministry of Forests, the MAA technique "explicitly recognizes the many dimensions of social and economic effects which influence land use decisions... [through] a framework of 'accounts' under which management options can be systematically assessed." The resulting assessment "may not indicate a single option which is clearly preferred, but it will indicate the advantages and disadvantages for each evaluation account" (Province of BC, 1992:2).

This chapter will trace the origins of multiple accounts analysis, examine the key reasons for its adoption in BC, and describe how MAA is intended to work. MAA will then be subjected to critical analysis, with reference to both theory and a brief review of past BC MAA studies. The focus of this critical analysis will be on how the maintenance of natural capital and environment-economy linkages are addressed, in MAA methodology and practice.

4.2 Origins of Multiple Accounts Analysis in BC

4.2.1 The Origins of Multiple Accounts Analysis

Cost-benefit analysis has been widely used in the US since the Flood Control Act of 1933. This legislation directed Federal Agencies to proceed with flood control and irrigation projects provided that "the benefits to whomsoever they may accrue are in excess of the estimated costs." In effect, agencies were directed to apply the Kaldor-Hicks criterion, also known as the potential pareto improvement criterion, advocated as a social decision rule by welfare economists. This criterion holds that society should proceed with those projects where the winners could compensate the losers, whether or not they do. If society consistently pursues such projects, economic output and welfare are argued to be maximized, and allocation is said to be efficient. Standard cost-benefit studies all rely on this criterion.

A critique of the Kaldor-Hicks criterion and allocative efficiency is beyond the scope of this research study (see Sen, 1987:32-34; Hausman and McPherson, 1996; Sagoff, 1988; Bromley, 1990). For numerous reasons, by the 1960s, there was increasing dissatisfaction in the US with basing project evaluation on this narrow rule of allocative efficiency. In 1962 a variety of US agencies produced the report "Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Land-Related Resources," approved as Senate Document No. 97, 87th Congress. This report recommended that in the development of water resources, development, environmental preservation and social well-being be considered equal objectives, each to be considered in a separate account. In 1973 the US Water Resources Commission formalized the application of Multiple Accounts Analysis in its Principles and Standards for Planning Water and Related Land Resources (Gunton et al., 1991:2-3). These principles were revised in 1979 and repealed in 1982. In 1983 they reappeared as guidelines, known as the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (Gunton et al., 1991:3).

In their brief review of the origins of MAA, Gunton et al. (1991) omit any consideration of the controversies that the Multiple Accounts Analysis methodology generated in the US, or the reasons for their repeal. According to economist Jack Knetsch, who at the time was working for the US Council on Environmental Quality, the Office of Management and Budget convinced government that Multiple Accounts Analysis was a flawed and inappropriate methodology (Knetsch, personal communication, May 5, 1997). One of the main criticisms of MAA at the time was that proper application of cost-benefit analysis techniques requires that the secondary benefits of hiring workers and other like expenditures not be counted as benefits, despite the increases in local economic activity that such hiring would generate. This is for two reasons. First, the local expenditures involved in any project funded by a national government are likely to be seen locally as benefits, while the funding involves a cost at the national level in order to finance the project. If a similar project involving equivalent levels of expenditures were to be located in a different region, then this region would expect similar secondary benefits. Secondly, to finance projects requires taxation revenue; tax collected by governments is no longer spent elsewhere in the economy (Treasury Board Secretariat, 1976:23-24). According to Knetsch, the Office of Management and Budget felt that proponents of Multiple Accounts Analysis were seeking a way to document local secondary benefits in their studies so that the benefits of public work schemes to regional economies would be apparent. In most cases, these local secondary benefits would help local politicians argue for their pet projects, even if they produced net losses at the national level (Knetsch, personal communication, May 5, 1997).

Deciding upon the appropriate boundaries for examining project impacts, local, regional, national, or international, is known as the "accounting stance problem." Vast differences in the perceptions of projects may arise depending on whether the study adopts a national, regional, or local perspective. Local and regional net benefits may often appear large because significant costs that accrue as downstream externalities, or that must be defrayed nationally by taxpayers, do not appear in regional accounts (Howe, 1987:20; Whittington and MacRae, 1986). In his review of MAA for the BC Roundtable and the Forest Resources Commission, Gunton (1991, 1992) never refers to these concerns.

4.2.2 Adoption of MAA by the Province of BC

The first use of Multiple Accounts Analysis in BC identified by Gunton et al., (1991) involved BC Hydro's review of the Revelstoke project, where accounts were used to describe the project's monetary, aesthetic, distributional and environmental impacts. In order to illustrate the potential usefulness of MAA to the resolution of land use conflicts in BC, Gunton et al., (1991) provide a case study based on a 1979 MAA conducted by the BC Ministry of Lands, Parks and Housing. The study involved a small region of 127 square miles in northern BC. Four options were under consideration: wilderness preservation; forestry; a combination of forestry and agriculture; and sale of the entire area for agricultural use. To evaluate each option, four accounts were used:

- provincial income account: net change in provincial social welfare based on a cost-benefit analysis;
- regional development account: impact of the option on regional income and employment;
- environmental account: impact on various environmental indicators; and

- government revenue and expenditure account: the impact on net government revenue once government expenditures associated with the option are deducted.

The case study is used to support the conclusion that MAA "is a flexible and comprehensive evaluation technique well suited to assessing land use conflicts in British Columbia" (Gunton et al., 1991:16). Unfortunately, this review of the 1979 case study lacks critical analysis. For instance, the government revenue account showed that option 4, sale of the land for agricultural purposes, produced the most government revenue. However, the study involves a fundamental mistake: it deems the proceeds from the sale of crown land to be revenue, biasing the analysis against any option which maintains the Crown's assets intact. The environmental account also reveals important flaws: wilderness preservation attains a score of 27 out of 27, while, in comparison, maximum sustained yield timber production attains an unrealistically high score of 25 out of 27. Only winter habitat and user aesthetics are considered to be impaired by the forestry option, an assessment of likely impacts that lacks credibility. In the Regional Development Account, wilderness preservation is deemed to have no direct employment or income benefits, an assessment that contradicts BC's experience as an ecotourism destination. The case study also fails to take into account that the long-term viability of the economy ultimately depends on resource extraction being excluded from certain areas to maintain the ecological integrity of the overall landscape. This latter omission is not unexpected, given the period in which the study took place. Reviewing the case study's integrated analysis, Gunton et al. conclude that the agricultural option is likely preferred, given that the "difference in provincial income at $42.9 million likely exceeds any reasonable estimate of intangible environmental values." (Gunton et al., 1991:15) From the perspective taken by these authors there appears to be no requirement to ensure that each option is sustainable, nor that financial or natural capital are maintained intact.

Despite the enthusiasm of proponents of MAA, a search of the economics literature to December 1996 failed to produce any references to Multiple Accounts Analysis, though there were a small number of references to Multiple Objective Analysis or Multiple Criterion Analysis. A review of these references indicated that most involved substantial differences with MAA as applied in BC. This suggests that there has been little theoretical development or critical review of MAA. Critical review is desirable to ensure the both the theory and the practice of MAA is sound.

The adoption of MAA in BC should be seen in the broader political context of the drive coming from diverse quarters to use economic analysis to aid or justify land use decisions. Participants in the forestry debate, from ecoforestry advocates like Herb Hammond or Michael M'Gonigle, to proponents of industrial forestry such as the BC Ministry of Forests and the Forest Alliance and its membership, have either suggested that economic analysis would contribute to better or more rational land use decisions, or have used economic analysis to support their interests (Hammond 1991:246; Province of BC, 1993; Price Waterhouse, 1995). For instance, M'Gonigle et al. claim that "the resolution of land use conflicts requires quantitative assessment of the tradeoffs involved" (M'Gonigle et al., 1992:357).

The interest in using economic analysis to achieve rational land and resource use decisions in BC parallels the hopes expressed by the US Senate. The Senate set out requirements for extensive economic analysis of management options for the US national forests, in the belief that the outputs of the analysis would replace political conflict with a more reasoned search for optimality (Healey and Ascher, 1995:8). A similar belief, that incorporating non-commodity functions into economic analysis would result in more rational, more knowledgeable, and more responsible decisions, has often been expressed in international forums (Healey and Ascher, 1995:2).

Since 1991, MAA has been a standard input to land and resource management planning evaluations in the province (G. E. Bridges, 1995:1; Province of BC 1993; Province of BC 1992). Guidelines have also been issued for reviewing the plans and projects undertaken by Crown corporations (Crown Corporations Secretariat, 1994). A useful research project would be to more fully investigate the reasons behind the BC government's enthusiastic adoption of MAA as an aid to land use decision making. Clearly one reason for such enthusiasm is the expectation that better decisions would result from applying MAA, and that decisions would be based on rational discussion and analysis rather than on protests and appeals to the court of public opinion. A more cynical interpretation would be that proponents of status quo policies within government, industry, and the IWA, recognized that MAA would document the economic costs of a more ecologically oriented land use strategy or forest policy in a way that would make change appear undesirable.

The hopes expressed by some that the outputs of standard tools of economic analysis would result in decisions more oriented toward sustainability, appear to have been misguided. Such hopes may have been based on a failure to examine the degree to which these tools fail to take requirements for sustainability into account. For instance, it is difficult to assign dollar values to ecological deterioration, and proponents of industrial forestry tend to deny or downplay such costs, such that these costs typically do not have much influence on the outputs of such studies or the decisions that rely upon them. Finally, even if an economic study demonstrated that industrial forestry was a poor economic choice, government and industry may well choose to ignore the study or to deny its findings. Despite such problems, a review of MAA studies for BC Wild, a conservation organization, remains optimistic. It lays the blame with practice, not theory, concluding that the multiple account framework is "sound" and that if "thoughtfully" applied it would consider all impacts "to the best of our current knowledge" (Jones, 1994).

MAA studies completed according to BC government guidelines typically make relatively modest claims about the usefulness of multiple accounts analysis. The Kamloops LRMP study states that MAA provides "a balanced representation of diverse--and possibly conflicting--values and concerns relative to alternative plan scenarios" (G.E. Bridges & Associates, 1994:7). A discussion paper for the Kamloops LRMP directed toward a more general audience explains that MAA does not define which scenario is preferred but rather "simply ensures decision-makers are aware of the tradeoffs and impacts expected to result from their choices." The intent of the discussion paper is "to assist the public in evaluating the various land use options. Public comment will be considered by the team as they work toward a final consensus-based recommendation..." (Province of BC, 1994:1).

Despite these and other such claims for the usefulness of MAA as a means to better understand the implications of various scenarios, to assess tradeoffs, and achieve consensus, the BC government commissioned a review of MAA because of concerns that MAA was not turning out to be a practical tool (Griggs et al., 1995:1). An environmentalist participating in the Kamloops LRMP wrote in a memo to the table that he found the MAA study unacceptable, misleading and slanted; claimed that it did not adequately show the impact of each option on sustainability; and concluded that MAA "should be abandoned to save time and money" (Cooperman, 1994a). Other participants in LRMP processes also critiqued MAA. In an open letter from the Kamloops Planning Team to all Kamloops LRMP participants, the team stated:

> ...The table has various views on the MAA's usefulness. Some LRMP members acknowledge the usefulness of the MAA as a tool in planning and for looking at the larger picture when considering the implications of their recommendations on communities and on people's lives. Others feel it is inaccurate and inadequate and that it reflects the worst case scenario (quoted in Mitchell, 1995:15).

In their review of MAA, ARA consultants similarly noted that many of the participants "stated that they did not use the MAA as a tool in making their decisions on the various land use scenarios..." (ARA Consulting, 1995: Chapter 2, p. 6). The study nonetheless concluded that MAA was a useful tool which the government should continue to use in such decision-making processes.

Given the widespread use of MAA in BC, and the ecological and economic importance of the decisions being made partly on the basis of such analysis, it is clearly useful to critically review MAA, focusing on how MAA addresses or should address the necessity to maintain natural capital intact. There are two ways in which this critical review can make an important contribution to better decision-making. The first way is for the results of such a critique to lead to revisions in MAA guidelines and improvements in the application of MAA. The other way in which this critical review can lead to a useful outcome is for participants in land use controversies to become better acquainted with the limitations and biases of MAA methods, thereby becoming more effective critics, allowing them to reject inadequate studies. Alternatively, they could use this new knowledge to discredit MAA studies generally, and apply their efforts in other ways to influence decision-making and to achieve desired objectives. They could, for instance, avoid participation in forest and land use planning processes which rely heavily upon MAA and choose to apply pressure by producing their own economic analysis, relying on alternative techniques, or by resorting to other means of applying public pressure.

4.3 BC's MAA Guidelines for Land Use Decision

To understand how multiple account analysis is to be carried out in BC, one must refer to two documents. The first is <u>Social and Economic Impact Assessment for Land and</u>

Resource Management Planning in British Columbia: Interim Guidelines, dated August 1993 (Province of BC, 1993; hereafter SEIA guidelines). The second is Resource Analysis Guidelines for Land and Resource Management Planning In British Columbia: Interim Guidelines, dated February 1995 (Province of BC, 1995; hereafter RA guidelines).

In the RA guidelines, the province defines resource analysis as "the critical examination of resources and the environment so as to support planning and decision-making" (Province of BC, 1995:3). Resource appraisal includes resource impact assessment, which "forecasts the effects of alternative land use designations and management strategies on the physical resources in the planning area...to help foster understanding of the implications of the scenarios and therefore facilitate the building of a consensus scenario" (Province of BC, 1995:29). Resource appraisal is used to gather relevant data, to identify management objectives, to develop indicators of resource levels and environmental conditions, to select analytical methods, and to describe the base case and assess the impacts of alternative scenarios. With these tasks complete, the outputs of the resource appraisal become inputs to the Multiple Accounts Analysis. As the RA guidelines explain:

> The forecast resource impacts for each scenario can have both positive and negative implications for the environment, the economy and local communities. Environmental implications may involve landscape aesthetics, biodiversity, pollution, resource depletion/enhancement, etc. Economic implications may involve jobs, resource prices, competitiveness, etc. (Province of BC, 1995:35).

Clearly, if MAA is to be a useful tool, resource appraisal and in particular resource impact assessment must be able to assess, as accurately as possible, how the environment will change as a result of different management policies, e.g., different rates of cut, different extraction techniques, kilometers of road building and the like. Herein lies a fundamental difficulty. The analyst must predict both environmental change and changes in resource flows. Yet it is extremely difficult to predict environmental change. The resource analyst is attempting to foresee the future of complex, dynamic systems under conditions of uncertainty. The analyst's ability to make predictions of ecosystem behavior based on the study of individual components isolated from the whole is extremely limited (Odum, 1993:29; Kay and Schneider, 1994:37).

Beyond theoretical difficulties, there are serious practical difficulties as well. A study looking into the selection and modelling of sustainability indicators for the Fraser River Basin concluded that existing data were of poor quality, inaccessible, and irrelevant. Out of 130 data series available for the basin, 68 had to be excluded because they were found not to be independently estimated, and a total of 83% had to be rejected because they were not statistically meaningful. Modelling future trends under such conditions would be extremely difficult, especially at smaller spatial scales (Lonergan et al., 1996). The MAA framework is therefore similarly likely to be erected on a base of poor data. Resource predictions are either the more-or-less well-considered guesses of specialists, or precise numbers generated by computer models of unknown predictive power fed imprecise data. Resource flows and ecological conditions predicted in a resource appraisal and used in a MAA thus may have little to do with the actual outcomes that will eventually be experienced.

4.3.1 Evaluation Accounts

The SEIA guidelines specify that the system of accounts should be divided on a regional and provincial basis. There are four regional evaluation accounts that take the perspective "of the people and communities within the planning area."

> **Regional economic development:** to document how each scenario "affects production, income and employment in various sectors of local economies."

Regional environmental values: to document how each scenario "affects the benefits derived from or the values attached to, non-commercial environmental resources and attributes in the planning area." Two basic effects are evaluated. The first, use-related values, addresses benefits from the use of environmental resources or human activity that is dependent on resources. The second, existence-related values, addresses the values attached to the existence and preservation of environmental resources.

Community characteristics and quality of life: to document "how each management option affects the nature and quality of life in communities in the planning area. Social impacts result primarily from changes in employment and land use."

Specific native community concerns: to document "how each management option affects native communities in the planning area."

Provincial evaluation accounts are intended to consider impacts on the province as a whole. Again, four evaluation accounts are proposed. The first two, Provincial Economic Development and Provincial Environmental Values, closely parallel the regional accounts. The other two have no regional equivalent.

Provincial government finances: to document "the effects of management options on provincial government revenues and expenditures to determine the net financial impact on the provincial government."

Economic efficiency of resource use: to document "how each management option affects the net economic benefits derived from all affected resources in the planning area."

4.3.2 Land and Resource Management Scenarios

The RA guidelines suggest that to facilitate evaluation and comparison, only three management scenarios should be specified, and that the range and values of interests contained in these scenarios are to be identified through public consultations. The base case must also be specified in order "to document the social and economic implications of different management options" relative to the status quo policies. The base case is a scenario which describes trends resulting from existing resource management policies and forest land use designations, set in the biophysical, economic and social context of the planning area (Province of BC, 1995:10).

For the forestry sector, the baseline case contemplated by the guidelines is based on the BC Forest Service timber supply projections. These projections typically involve maintaining the current AAC until the old-growth is liquidated, at which point "falldown" occurs and AAC falls to the Long Run Sustained Yield. There is no requirement that the study team assess whether such status quo projections are biophysically and ecologically realistic, despite widespread concern that such rates of cut cannot and should not be maintained, and that the time at which falldown will occur and the level of the LRSY are subject to considerable uncertainty.

4.3.3 Evaluation of Impacts of Management Scenarios

For the provincial and regional evaluation economic account, the SEIA guidelines set out an evaluation method involving four steps. For the regional account, the relevant industries are those in the planning area; for the provincial account, the relevant industries are those outside of the planning area. The steps are as follows.

1. Identify those industries that would be affected by the management plan.
2. Estimate how changes in resource availability due to the management plan will affect production and revenue for each resource-dependent industry or activity.
3. Estimate how changes in production and revenue will affect income and employment in resource-dependent industries and activities.
4. Apply multipliers based on income-expenditure models to determine total income and employment effects (Province of BC, 1993:12-16; 23-24).

The SEIA guidelines set out a similar approach to document impacts on regional environmental values:

1. Identify non-commercial uses of environmental resources.
2. Through community consultation, identify environmental values that may be affected by management plans. These values are grouped into ecological, aesthetic and cultural categories.
3. Impacts on the uses of environmental resources are estimated "from the linkage between the resources and their uses and the nature and magnitude of the impacts."
4. The nature and extent of impacts on environmental values are documented using the qualitative indicators from the biophysical analysis.
5. The significance of the impacts is assessed in qualitative terms, based on the size of the impacts and the "importance of the uses and values to the affected communities" (Province of BC, 1993:18).

The provincial environmental values account is similar to the regional account, except that the focus is on the non-commercial uses of environmental values by persons from outside of the planning area and the impacts of management options on provincial environmental policy objectives (Province of BC, 1993:25).

As written, the SEIA guidelines appear to characterize the environment as an amenity or as a desirable feature. Environmental impacts at the regional level are only important to the extent that they interfere with recreational or other such uses. Impacts on resources are documented if they are "valued because of their use or because of the importance people attach to their existence and preservation" (Province of BC, 1993:9). The guidelines downplay the environment as the source of resource flows and services which depend on the maintenance of ecological integrity. At the provincial level, environmental accounts focus on the extent to which persons from outside of the planning area use the environmental resources in the planning area, and the extent to which provincial environmental policy objectives are met by the resource management scenarios in question.

4.4 Resource Appraisal Guidelines for Resource Impact Assessment

4.4.1 The Base Case

Provincial guidelines require that resource appraisal be carried out for the base case in the same manner and over the same time frame as for each of the alternative scenarios. It involves projecting "current land uses and management practices into the future." The guidelines admit that projected future conditions "involve about as many assumptions and uncertainties as for the alternative plan scenarios" (Province of BC, 1995:30).

4.4.2 Alternative Scenarios

Impact assessments for each land use scenario under consideration are intended to document the nature and extent of impacts on the environment and resources, as well as how these impacts differ from those which would be experienced under the base case. The impact assessment for a given resource, say, water, must not only take into account the water resource management scenario, but also management plans for other resources such as timber. Both direct and indirect impacts must be considered. Therefore, if timber extraction affects water quality which affects the fishery, this indirect impact must be taken into account, until forest cover is restored, water quality improves, and the fishery recovers (Province of BC, 1995:31).

4.4.3 Tools for Multi-Resource Impact Assessment

The guidelines admit that few tools are available for the analyst to evaluate and compare such multi-resource management strategies and interaction; those tools proposed for the analyst's consideration, include the following:

Qualitative index matrices, interaction matrices, multicriterion decision-making techniques: Qualitative index indices provide an ordinal ranking of impacts on a numerical scale such as +3 to -3. While acknowledging that such an index loses much information by translating all impacts to numbers, and that such indexes assess environmental impacts without reference to complex ecological linkages, the guidelines suggest that, due to inadequate knowledge of many ecological impacts, the only alternative to an index is often highly questionable guesses. While an index may be used to compare impacts, the index-based techniques do not assist the analyst in assessing impacts in the first place. In a similar vein, the guidelines propose that analysts consider interaction matrices and multicriterion decision-making techniques, noting that these methods are not useful for predicting impacts but can be useful for screening purposes.

Simulation models can help the analyst to gain an understanding of a complex model, and to test what-if scenarios, by constructing and manipulating a simplified model. Simulation models exist for BC forest estate modeling. The guidelines acknowledge that, as more details are included in a model, the number of explicit assumptions about the interactions between variables rises exponentially, as does the probability of making a wrong assumption.

Multi-resource impact assessment models involve simulation models intended to mimic interactions of resources in a landscape, using Geographic Information Systems as an integrating device (Province of BC, 1995:32-34).

4.4.4 Assessing Impacts on Individual Resources

The Guidelines then set out resource analysis methods for each of the resources that must be considered under LRMP. These resources are:

--biodiversity

--agricultural land and range

--aquaculture

--cultural heritage resources

--energy

--fish, fish habitat, and fisheries

--minerals

--protected areas

--recreation

--timber

--tourism

--water and water quality

--wildlife and wildlife habitat.

Since the emphasis of this research paper is on the maintenance of natural capital in a forested landscape, the following briefly reviews the methods recommended by the RA guidelines to assess impacts on biodiversity, habitat and forest resources.

Biodiversity: the guidelines note that four provincial initiatives provide an indirect means to conserve biodiversity, by maintaining those things that are thought to support or determine biodiversity such as habitat. The Protected Areas Strategy is an initiative intended to ensure the protection from development of representative areas of each ecosystem type from across the province. Draft Coastal Biodiversity Guidelines and the Interior Fish, Forestry and Wildlife Guidelines are based on the "assumption that genetic and functional diversity can be sustained by maintaining a broad geographic distribution of ecosystems and species, and that the habitat needs of most forest-dwelling organisms can be satisfied by maintaining a variety of forest stand attributes and structures, patch sizes and seral stages across a variety of ecosystems and landscapes." Finally, according to the guidelines, the Forest Practices Code regulates forestry operations to ensure that the above initiatives are followed. The guidelines then put forth the position that if the above initiatives are implemented under a given management scenario, there is no need to assess impacts on biodiversity, since biodiversity has been accounted for in a straightforward and achievable manner (Province of BC, 1995:40).

There are numerous reasons to challenge the conclusion that the implementation of provincial initiatives will adequately protect biodiversity. In their review of the Protected

Areas Strategy, conservation biologists Sanjayan and Soulé (1997) conclude that the target of protecting 12% of the land base is not biologically defensible, and that the small size of many of the protected areas limits their ability to contribute to the protection of biodiversity. They also challenge an assumption implicit within the Protected Areas Strategy that the land base outside of protected areas will contribute to the preservation of biodiversity. They note that, under land use plans currently approved, the majority of forested ecosystems are either designated as general forestry areas or High Intensity Areas, and that ecological integrity can be expected to deteriorate in such unprotected areas under proposed industrial management regimes (Sanjayan and Soulé, 1997:15). Indeed, the BC government set a 6% cap on the amount that the Forest Practices Code's provisions could affect the AAC. Furthermore, the high biodiversity designation is not to apply to more than 10% of the land base affected by the Code, and biodiversity requirements may be relaxed if they would have a significant effect on the AAC (M'Gonigle, 1997:19; BC Ministries of Forests and Environment, 1995:9). Taking these factors into consideration, study teams involved in resource appraisal should not assume that existing guidelines will protect biodiversity. Instead, within the confines of existing MAA and RA guidelines, it would be more legitimate for analysts to examine the impact of various land use scenarios in a way that includes critical assessment of the effectiveness of related policies.

Fisheries Resources: A three step method is recommended for assessing impacts on fisheries resources: estimate the level of human activity in each watershed; define the effect these activities will have on fish habitat; use these relationships to estimate impacts on specific watersheds and habitats. The guidelines emphasize the relationship between water quality and the fishery; the pressure that access imposes on the fishery and the importance of maintaining fishery habitat (Province of BC, 1995:61-64). Again, the guidelines do not provide much guidance on how actual impacts can be assessed.

Timber supply: The guidelines provide a detailed explanation of the methodology to be used to determine the impacts of management options on timber supply. The guidelines note that significant proportions of the land base are not suitable for timber extraction. Deductions must be made for: non-Crown land, non-forest land, non-merchantable forest types, environmentally sensitive areas, inoperable areas, streamside buffer areas, Forest Ecosystem Networks (FENs), and areas used in creating roads and landings (Province of BC, 1995:73-80). The assumption is, however, that unless land is unsuitable for timber it is to be used for timber extraction, an approach at odds with ecosystem-based planning. The guidelines do not mention the need to account for interdependencies. For instance, if land use and timber extraction fail to provide adequate habitat for insectivorous birds, to protect biodiversity, and to maintain soil productivity, impacts on timber production levels would be expected, yet the guidelines do not require that such interactions be taken into account. The methodology includes an implicit assumption that the liquidation of natural capital is fully acceptable and standard practice. According to the guidelines, the "surplus stock" in unmanaged stands "can be held or liquidated." The definition of the Long Run Sustained Yield (LRSY) as "the maximum harvest level that can be sustained in perpetuity," is likely to introduce an additional bias against maintenance of natural capital. It is equivalent to the concept of maximum sustained yield (MSY). By focusing on maximum output, rather than output levels set to provide a precautionary margin, the MSY provides little maneuvering room for resource managers to leave some of the stock of natural capital unharnessed in order to allow the ecosystem to build up ecological legacies, to allow natural disturbance regimes to run their course, to account for the variability of the ecological system, or to provide for maintenance of redundancies and ecosystem health. By focusing on a single output, it implies managing ecosystems in a way that increases brittleness and the potential for catastrophic changes in system dynamics (Holling, 1994:64). It focuses the manager's efforts on volume over quality (Baskerville, 1990), on timber over other values and other ecosystem components (Hammond, 1991:47). There is widespread agreement that the concept of Maximum Sustained Yield, as applied to fisheries resources, was unfortunate, and that it is an inappropriate model for resource exploitation in general (Ludwig et al., 1993).

Wildlife and Wildlife Habitat: The guidelines state that government has shifted from managing for desired species to managing for wildlife and habitat resources. Habitat importance indicators need to be developed such that important habitat areas can be identified, both to help define land use scenarios, and to enable habitat impact analysis of scenarios under consideration. While identifying and protecting critical and important habitats is important, it does not ensure landscape level functioning will be maintained. Indeed, until the AAC is reduced, it would be difficult for the government to make such designations. These designations either reduce the area of the productive landscape from which the AAC is calculated, or they reduce the potential cut because more restrictive standards would apply on various landscape units. Either of these changes require a reduction in the AAC. The Forest Practices Code provides for the designation of landscape units, wildlife habitat areas, sensitive areas, old growth management areas, and the designation of identified wildlife species (species at risk that require special management practices). As of November 1996, no such designations had been made (Sierra Legal Defense Fund, 1997b; M'Gonigle, 1997).

4.4.5 Resource Appraisal and Maintenance of Natural Capital

It is clear then that the resource appraisal guidelines contain no requirement to ensure that natural capital stocks will be maintained or that resource use will be ecologically sustainable. The techniques proposed for analysis are poorly suited to obtaining a realistic view of the interactions between ecosystem components and desired flows of resources.

The resource appraisal model relies on making inherently difficult cause-effect predictions, and is therefore ill-suited to situations involving complex systems, uncertainty and novelty.

Because MAA relies heavily on Resource Appraisal, both for the flows of resources that are expected to be extracted under a given management regime, and as an input to environmental values accounts, the reliability of MAA is much reduced by the weaknesses documented above. However, it is not so much that the Resource Appraisal guidelines are inadequate; rather, the entire model of setting target levels of resource use and then assessing likely impacts is flawed. The emphasis should shift instead to identifying, as best one can, the limits of the ecological system in question, and the conditions under which resource extraction can occur without compromising ecosystem health. The approach and principles set out by the Scientific Panel for Sustainable Forest Practices in Clayoquot Sound (1995b) would be one example of how such limits and conditions could be defined. Land use proposals and plans for resource extraction which exceed these ecosystem thresholds can then be analyzed by documenting how thresholds would be exceeded and by specifying the likely range of ecological and resource flow consequences, all the while noting uncertainties, and the potential for and consequences of irreversibilities. This approach does not eliminate conflict or uncertainty; rather, it shifts the debate towards defining limits and conditions under which natural capital is maintained.

4.5 Resource Appraisal, Multiple Accounts Analysis and the Maintenance of Natural Capital: Practice in BC

The intent of this section is to document how Resource Appraisal and Multiple Accounts Analysis studies from different areas in BC predict how management regimes will lead to the partial depletion of the resource base and reductions in ecological integrity, without adjusting the economic accounts accordingly. This is to show how such studies currently fail to take into account the depletion of natural capital. A later section will examine RA and MAA in the Kootenay/Boundary area, which includes the Slocan Valley.

4.5.1 Kamloops LRMP Area

The biodiversity analysis report for the Kamloops LRMP area is eight pages long, hardly an adequate basis upon which to determine the implications of proposed land and resource management plans on biodiversity over the very long term. The analysis was supported by the use of GIS mapping of resource management regimes and infrastructure development at a 1:250 000 scale. This mapping was intended to enable the analysts to assess landscape diversity and stand diversity. The analysts assumed that provincial initiatives would meet stand level biodiversity requirements (Ministry of Environment and Lands and Ministry of Forests, 1994:5). The analysis only addressed biodiversity at the landscape level.

The biodiversity analysis report rates each scenario on a 5 point scale from -2 to +2, each rating being relative to the base case. A rating of +2 does not mean that biodiversity will be maintained, but rather that the loss of biodiversity will be significantly slower than in the status quo scenario. Despite the significant loss of biodiversity expected with status quo policies, the base case scenario takes as given current timber extraction levels and government revenue projections, making no mention of how extraction levels are likely to drop due to the increasing brittleness of ecological systems (see Kamloops LRMP Planning Team, 1994:5). Other scenarios are therefore assessed against an implausible base case with overly optimistic projections of resource flows.

Background studies prepared in support of the Kamloops MAA then evaluate four scenarios; scenario 1 is the most ecologically conservative, while scenarios 2 through 4 focus more on accommodating development. From the report, the statements reflect upon how each scenario would affect natural capital.

Scenario 1

- LRSY reduced by 21% over baseline.
- "High potential" for maintaining biodiversity. "Moderate" protection of habitat wildlife, although only 11% of caribou, goat, grizzly and marten habitat would see an enhanced level of protection.
- 228 of 2009 lakes would be protected from future development. While the remainder would not be protected, they would receive some protection from the establishment of ecosystem networks. Risks to anadromous fisheries are reduced by curtailments of development activities in 23 of the 40 salmon-bearing watersheds.

Scenario 2

- 0.1% decrease in the LRSY.
- Protected areas "are dispersed and relatively small, and there is minimal connectivity between them. This may lead to further fragmentation of habitat and reduced viability of certain ecosystems which are under stress...this scenario has low potential for maintaining biodiversity."
- Marginal improvement in habitat protection over the base case.
- This scenario "could lead to an increased risk of reduction in fish habitat capability...[it] offers the least amount of benefit to the salmon resource."
- This scenario "achieves only a few of the provincial goals regarding representation and protection of ecosystems...many of the protected areas may be too small to protect biodiversity..."

Scenario 3

- 17% decrease in the LRSY
- a "moderate improvement in maintaining biodiversity as compared to the base case."
- Outside of protected areas, the potential for maintaining biodiversity is "moderately good".
- There is "marginal to moderate" improvement in the protection of wildlife habitat and moderate benefit to anadromous fisheries.

Scenario 4

- 8% reduction in the LRSY
- low potential for maintaining biodiversity outside of protected areas
- marginal improvement in the protection of wildlife habitat, fish habitat, or the anadromous fishery (Kamloops LRMP Planning Team, 1994).

It is clear from the report that Scenarios 2 through 4 involve substantial declines in natural capital. A critical examination of Scenario 1, the most ecologically conservative scenario, makes it clear that it also involves depleting natural capital. In Scenario 1, the LRSY is reduced by only 21%, which, although a substantial reduction, still implies that most of the productive landbase will be managed for intensive timber production, such that most of the forest will be converted into plantation forests. The report's conclusion that there is high potential for maintaining biodiversity can be disputed. Although over the short and medium term biodiversity may be maintained within protected areas, the theory of island biogeography, and recent evidence from National Parks, suggest that such protected areas, which would become the equivalent of ecological islands surrounded by a manipulated landscape, would lose genetic and species diversity over the long term (Odum, 1993:214; Quammen, 1997). There is also little reason to expect that provincial guidelines for stand level biodiversity requirements will prove effective.

It is clear then that all of the scenarios involve land use designations and a rate of timber extraction that imply the consumption of natural capital. Yet, in the economic accounts of the MAA, no adjustments are made in any of the scenarios to revenue or other economic benefits to account for the depletion of natural capital (see G.E. Bridges and Associates, 1994).

The final recommendation for the Kamloops LRMP involves resource extraction and land use much the same as in the base case. For instance, the LRSY is projected to decline by less than 1%, government revenue decreases by a mere $400 000 out of almost $200 million (Kamloops LRMP Team, 1995a, b). Despite this continued aggressive resource extraction regime, the MAA shows that the recommended scenario provides improvements in all environmental accounts since this scenario does not cause declines in environmental conditions as quickly as would be experienced under the status quo base case. While environmental conditions may not deteriorate as rapidly, this scenario still involves substantial unreported natural capital consumption.

4.5.2 Kispiox Area

The province's MAA guidelines refer to the Kispiox Socio-Economic Impact Assessment as a useful example of a study which follows the guidelines (Province of BC, 1993). An analysis of the potential effects on fish and wildlife of the options under consideration in the Kispiox area shows significant negative effects are expected on fish and wildlife resources. For instance, the analysis indicates "a steady decline in bear habitat as harvesting progresses...Even under these options [intended to protect bear habitat] bears will be adversely impacted as access expands" (Wolfe, 1991:14). A biodiversity analysis for the Kispiox region includes graphs of future levels of biodiversity. The x-axis on these graphs represents the next 200 years, and the y-axis represents levels of biodiversity based on a scale which ranges from "much better than" to "much worse than" initial conditions. These graphs plot an initial enhancement of biodiversity, based on the premise that timber extraction will disturb currently homogenous areas of low biodiversity, resulting in a range of successional stages and hence increased biodiversity (Fuhr and Pojar, n.d.: 2). However, viewing the human-induced disturbance as a mechanism for enhancing biodiversity is rejected in the literature, except in specific instances where past human intervention has suppressed ecological processes and created a homogenous landscape which would not normally have occurred (Schowalter, 1996:24), or in traditional management systems of indigenous peoples (see for instance Cronin, 1983). While it is recognized that fire suppression efforts have had this effect in many forests in BC, standard clearcutting methods are rarely a satisfactory substitute for natural disturbance mechanisms. Although the forest industry often argues that clearcutting old growth increases biodiversity, when this claim is subject to even elementary analysis it is clear that it is not based on a scientific understanding of the purpose behind conserving biodiversity and the mechanisms by which this goal can be reached (Pielou, 1996:22).

Despite adopting a position which largely underestimates the loss of biodiversity, the report nevertheless documents that the natural capital of the Kispiox region will eventually be much depleted. Most of the biodiversity curves graphed in the report show long term biodiversity to decline significantly. The authors' portrait of the landscape after several decades of the proposed management regime captures this loss with few words: "very little old growth remains...little deciduous forest...loss of most coarse woody debris" (Fuhr and Pojar, n.d.). Overall, this brief report, based on many claims unsubstantiated by appropriate references or studies, hardly seems sufficient for a thorough assessment of how biodiversity is likely to be impacted. The consensus option for Kispiox involves clearcutting in 89% of cutblocks (Holman and Cooke, 1992:19). As shown in Chapter 3, this is a further indication that the requirement to maintain natural capital intact is not accepted or heeded.

Despite the anticipated decline in the level of natural capital for the Kispiox region under the base case scenario and alternative scenarios under consideration, the MAA does not even mention ecological deterioration or reduced biodiversity as reasons why future timber extraction levels would fail to be met (Holman and Cooke, 1992:10). Yet in the biodiversity analysis, the authors write,

> <u>Biodiversity is fundamental to life and the sustainable supply of all renewable resources in the T. S. A.</u> In the long term, a negative biodiversity curve implies: ...less stand-level resistance to pests, disease and climate change (Fuhr and Pojar, n.d.: 1; emphasis in the original).

It appears that timber supply projections are taken as given in MAA studies, even if resource analysis suggests that there are reasons why subsequent yields might fail to be achieved.

4.5.3 Bulkley Timber Supply Area

A background study to assess the effects on fish and wildlife resources of the base case versus the consensus decision states that, with respect to the environment, "analysis will become more quantitative (objective) once habitat resources inventories are completed. However, in the interim, a degree of subjectivity exists...with projected effects being partially based on 'best biological opinion'" (Vanderstar, 1996:8). Despite the dearth of inventory data needed to support resource analysis, the analysis is carried out with whatever data is at hand, and decisions are taken on the basis of such analysis.

Numerical values are assigned to various ecological indicators, based on an unusual scale where +5 indicates no negative impact, whereas +1 to +4 indicate that "impacts prevent the achievement of optimal conditions," 0 which indicates that the impact is detrimental "without taking away from the overall cumulative assessment of the account," and where -5 indicates serious consequences.

Impacts on various feature species are then assessed by comparing them to BC Environment's "minimum desired population level for the species in question" (Vanderstar, 1996:13). In essence, these impacts are being compared not against existing levels of natural capital, but against minimum levels. If current levels are higher than those minimum levels, then natural capital depletion caused by resource extraction is acceptable so long as environmental degradation is within bounds considered acceptable by the Ministry. One would hope that the minimum levels established by the Ministry of Environment are set sufficiently cautiously so as to make the maintenance of ecological integrity or ecosystem health likely. However, depletion of natural capital below these minimum target levels is expected under the consensus scenario. Over the long term, the extirpation of the last remaining caribou herd in the TSA is expected due to landscape development, increased predation, and decreased arboreal lichen availability (Vanderstar 1996:23). Stream fish habitat loss is expected (Vanderstar, 1996:43). Unless the AAC drops quickly to the LRSY, the loss of old growth habitat will cause significant impacts on old-growth dependent species (Vanderstar, 1996:56). Forest fragmentation and loss of stand attributes in Enhanced Timber Areas will contribute to a loss of connectivity. This will be partially offset by ecosystem networks, the effectiveness of which remains uncertain (Vanderstar, 1996:59). It should be noted that the base case involves unacceptable levels according to Ministry of Environment minimum standards for all environmental indicators. Once again, despite the failure to maintain natural capital intact, no adjustments are made to the economic analysis.

4.6 Kootenay-Boundary LUP Resource Appraisal and Multiple Accounts Analysis

The Slocan Valley is situated within the boundaries of the Kootenay-Boundary Land Use Plan (KBLUP) area. It is appropriate then to examine how resource appraisal and multiple accounts analysis for this region has addressed the necessity of maintaining natural capital intact. The Slocan Valley region of the KBLUP must be considered in the context of the timber supply analysis for the Arrow Timber Supply Area, as well as the license provisions of the Tree Farm License #3, held by Slocan Forest Products. The timber supply analysis indicates that a significant falldown is expected to occur once existing older timber supplies are liquidated. For instance, in the Arrow TSA the LRSY is 422 000 m^3/year versus the current AAC of 619 000 m^3/year calculated in 1994 (Ministry of Forests, 1994:14). Calculations by the Economics and Trade Branch indicate that the total AAC for the Slocan Valley including TFL#3 is 225 000 m^3, while the LRSY is 174 079 m^3 (Economics and Trade Branch, 1996:15). The Arrow Timber Supply analysis indicates that the base case, which delays reductions of the AAC to the LRSY for seven decades, was chosen with the intent of "maintaining current harvest levels for as long as possible" (Ministry of Forests, 1994:14). The timber supply analysis includes sensitivity analysis to account for uncertainties. It evaluates the LRSY as harvest flows are manipulated, minimum harvest ages are changed, estimates of stand values are varied, regenerated stand volumes prove different than expected, etc. However, these scenarios do not consider the possibility that there will be significant declines in timber production as ecosystems become more brittle and hence likely to flip into a persistently degraded state as a result of disturbance due to extensive modification and management focus on a single resource (Holling, 1994). Long term timber yields and economic projections may therefore have limited plausibility, even under an intensive industrial forestry regime.

A biodiversity assessment carried out for the KBLUP indicates that the base case, which involves the current AAC as determined in the Timber Supply Review (TSR), involves very high risk to caribou habitat (Hamilton and Utzig, 1995:10). Otherwise, this assessment contains few projections of future ecological conditions, concentrating instead on defining objectives and criteria. In the overall environmental impact analysis for the area, the base case is found to result in:

--high to very high risk to general biodiversity

--severe compromising of landscape connectivity

--high to very high risk to grizzly habitat

--high to very high risk to ungulate winter range

--high to very high risk to regionally significant fisheries (ARA Consulting and Robinson Consulting, 1996:2-3).

Despite this across the board indication of a failure in the base case scenario to maintain natural capital intact, the analysis fails to indicate that the AAC is unlikely, for ecological reasons, to be maintained. Nor is government revenue adjusted, either to account for the depletion of natural capital, to take into account the broader economic ramifications of extensive environmental degradation, or to account for government expense in managing industrial forestry. For instance, the socio-economic analysis for the Arrow TSA includes a section devoted to the analysis of government revenues, but no examination of government expenses (see RSMI, 1994:Chapter 6). Finally, no adjustment is made to reflect the fact that the quality of extracted timber will be reduced as the transition is made from old growth to second growth forests. Average age of timber extracted for the Arrow TSA is projected to decline rapidly from an average of 234 years at present, to 140 years in 40 years, to a low of 110 years in 110 years. It eventually is projected to stabilize at 120 years (Ministry of Forests 1994:19). No breakdown is provided for the Slocan Valley proper, though average age of currently extracted timber is likely lower than the Arrow TSA average, due to the fires which burned through the valley at the turn of the century, and to the valley's logging history. Such changes in average age may affect the uses to which timber may be put, forest industry outputs and profits, and government revenue. The key point is that timber quality as well as quantity influences the value of both stocks and flows, and the economic activity that such flows may support, and apparently none of the MAA studies makes the appropriate adjustment.

The base case is compared to the approved Kootenay Boundary Land Use Plan. While an improvement from the base case, the approved plan is clearly based on the continued consumption of natural capital. It involves:

--minimal improvement in protected area representation

--lower but still significant risk to landscape connectivity

--uncertain improvements in protection of grizzly bear habitat

--a failure to achieve low risk management for fish and wildlife habitat, though the situation is significantly improved over the base case (ARA Consulting and Robinson Consulting, 1996:2-7).

It should be noted that this assessment of environmental impacts was carried out on behalf of the government by consultants, and it does not include external assessment or criticism. There has been extensive criticism of the KBLUP, as evidenced by the protests during the summer of 1997 against logging in Slocan Valley watersheds, frequent letters to the editor, and external reports such as hydrology assessments, which predict extensive landsliding, road failures, and deterioration of watersheds (Isaacson, 1996). Yet the impacts on domestic watersheds are not even assessed in the environmental accounts.

At this point in this study it is sufficient to demonstrate two things. First, both the base case and approved plan which influence timber extraction in the Slocan Valley are admitted by government to result in substantial declines in environmental quality, or in other words to involve the consumption of natural capital. Second, the economic accounts have not been adjusted to account for the depletion of natural capital. Given that both these matters have been demonstrated, it is possible to conclude that the MAA for the region within which the Slocan Valley region is situated does not follow best practise in the use of economic accounting and analysis.

4.7 Reviews and Critiques of Multiple Accounts Analysis and Resource Appraisal

4.7.1 Critique of MAA Commissioned by Ministry of Environment, Lands and Parks

The Ministry of Environment, Lands and Parks commissioned a study by three separate consulting teams to review and recommend improvements to the use of MAA to support Land and Resource Management Planning. While many of the recommendations address matters of limited interest to this research study, a number are relevant to whether and how the analysis accounts for natural capital.

The review recommended that the environmental analysis for the base case be made more comprehensive, including explicit assessment of risks and uncertainties (Griggs et al., 1995:10). It documented how the assessment of environmental impacts in LRMP multiple accounts studies has proven to be very difficult, given that analysts face actions which are "diffuse in nature, 'impacts' are difficult to capture, and potential 'impacts' occur over a long period of time" (Griggs et al., 1995:I, p. 10). Furthermore, environmental information was found to be consistently underemphasized, or to be of limited use to support decision-making. For instance, the environmental accounts would assess whether all ecosystem types were represented by protected areas without commenting on whether these same protected areas were ecologically viable (Griggs et al, 1995:III, p. 6).

The economic accounts were found to be "limited to simplistic analyses, reflecting the limited time available for undertaking these tasks. It was also noted that the economic analysis often appears to be driven by forest indicators--the only sector where potential resource use can be tied to a single resource use factor--timber volume" (Griggs et al., 1995: I, p. 15). Linkages between the environment and the economy were poorly represented, making the preparation of an integrated resource plan difficult (Griggs et al.. 1995: II Sect. 2, p. 2). Although the guidelines for Multiple Accounts Analysis specify that one of the accounts should examine the economic efficiency of resource use, it has not been included in most studies to support LRMP processes (Griggs et al., 1995: II Chapter 2, p. 10).

The consultants considered but rejected recommending that the base case be defined as a scenario which ensures environmental sustainability, and then assessing alternatives against this base case, rather than the status quo. This approach was rejected because it "would require a significant contribution of time and resources, and could lead to contentious debate rather than further clarity" (Griggs et al, 1995: III, p. 4). Unfortunately, the consultants failed to debate the theoretical and analytical merits of this approach.

4.7.2 Review of MAA by G.E. Bridges and Associates

G.E. Bridges, a leading practitioner of MAA studies in BC, prepared an assessment of MAA for the Clearwater Forest District. Bridges concludes that the perceived ineffectiveness of MAA is partly due to the fact that MAA

> ...was never designed to support or to be used in a public involvement process. An important methodological limitation that

> often gets overlooked, is that MAA does not provide definitive solutions to conflicting alternatives. MAA only attempts to identify a "price tag" in terms of forgone income or employment, of pursuing environmental preservation objectives (Bridges, 1995:5).

This perspective implies that the pursuit of environmental objectives is an optional social objective, rather than a prerequisite for continued economic activity. It is also inconsistent with an analytical approach that builds on accepted definitions of income interpreted in the context of a full world.

Bridges observes that since 1992 the application of MAA has excluded the economic efficiency account, a shortcut which compromises the methodological integrity of MAA and which deviates from provincial guidelines. Without the pivotal economic efficiency account, Bridges argues, one does not have the price tag "against which the benefits of preservation alternatives can be evaluated"[9] (Bridges, 1995:10). Furthermore, alternatives which maximize economic efficiency or provincial income over the long term, and therefore maximize employment through re-investment in the economy, may fail to be identified when the focus is on minimizing short term unemployment if no economic efficiency analysis is undertaken (Bridges, 1995:6).

4.7.3 Jim Cooperman's Critique

Jim Cooperman, of the Shuswap Environmental Action Society, has been an outspoken critic of MAA and economic analysis of forestry generally. Cooperman's thesis is seen in his criticism of the Okanagan Timber Supply Review Socio-Economic Analysis:

> A commitment to sustainability means managing resources today so that future generations will not be deprived. The [Okanagan socio-economic analysis] report primarily is concerned with the need to continue the extraction of resources today instead of conserving our resources for the future.

[9] Note that this contradicts the earlier quote taken from the same report, where the price of environmental preservation is seen in terms of jobs.

In an article on the Multiple Accounts Analysis in the BC Environment Report, Cooperman writes,

> The common denominator for nearly every land-use decision today is based on the question, "How many jobs will be lost?" ...the main goal is to minimize the impact on the economy. In order to estimate what that impact might be, the government contracts consultants to produce socio-economic analyses... The results of these studies are then often flogged in the media by industry supporters in an attempt to maintain the status quo at the expense of long range sustainability...
>
> The government economists are focusing on the wrong question. Instead of just asking "can we afford to change?" they should be asking "can we afford not to change?" The studies done to date do not adequately investigate the impact that current land use patterns and rates of cut have on ecological sustainability (Cooperman, 1994b).

Cooperman rejects the use of an unsustainable baseline scenario as a basis for defining impacts. Instead, ecological analysis should be carried out first in order to provide a basis for developing ecologically feasible options that can then be assessed by LRMP participants (Cooperman, 1994b).

Cooperman's critique can be seen as addressing the necessity of maintaining natural capital intact, although he never uses these exact terms. But his critique extends beyond this issue to cover what he believes are simplistic, biased analyses which systematically overstate the importance of the timber industry and the costs of transition to a lower AAC, while understating the ability of communities to adapt.

4.7.4 Critique of Resource Analysis Commissioned by Ministry of Environment, Lands and Parks

The Ministry of Environment, Lands and Parks commissioned a review of Resource Analysis approaches for LRMP by three consulting groups (Salsan Associates et al., 1996). In their review of six resource analysis reports, a number of serious shortcomings are identified, which give little confidence that resource appraisal can predict the consequences of alternative courses of action which have such important long term consequences. A number of observations from the report in support of this conclusion include:

- the Kispiox biodiversity analysis was a "back of the envelope" effort;
- the limitations of or problems encountered when conducting an analysis were often inadequately documented;
- methodology was inadequately discussed and poorly referenced;
- linkages between indicators and variables were not always clearly specified;
- the analysis typically assumed that the Forest Practices Code and associated guidelines would be effectively implemented and would meet needs of habitat preservation, biodiversity, and protection of riparian habitat, assumptions that may not be true;
- time committed to the analysis varied widely;
- ground-checking is required to ensure credibility and usefulness;
- expert opinion expressed directly at the LRMP table held more sway than Resource Appraisal with a "bunch of fuzzy numbers;"
- while LRMP participants seek assessment of long term risk to specific indicators such as population levels of desired species, analysts are reluctant to provide the assessment due to "the high degree of uncertainty and wide range of other factors that may be critical for long term viability;"
- lack of data was and continues to be a problem;
- analysts had to work within bounds set by government such as constraints on the amount that the AAC could be reduced;
- information on important resources was often completely missing, such as fisheries for the Vanderhoof LRMP, or water more generally;

- the analysis often failed to identify key requirements for maintaining environmental resources at sustainable levels;
- the base case was often based on current conditions, rather than "anticipated future conditions resulting from present management practices;" and
- key assumptions remained implicit or buried in the analysis, even where substantial environmental impacts would result from minor changes to assumptions such as timber operability lines.

These problems were identified despite the consultants limiting their review mainly to interviews with staff and consultants who had participated in preparing earlier resource appraisal studies. The review failed to seek critical opinion from outsiders, and it apparently did not involve a peer review of the resource appraisal studies in question to determine the quality of the scientific research or opinions provided to LRMP participants.

Resource appraisal practitioners apparently believed that impact assessment could be completed within six to fifteen days of knowledgeable staff time, provided there was adequate inventory information and analysis support tools such as GIS (Salsan et al., 1996:48). It is surprising that Salsan et al., rather than challenging such an inadequate investment of resources, recommended instead that RA study teams carefully evaluate analysis methodologies to ensure they could produce results within the required time frame.

4.7.5 Critique by Jones for BC Wild

Trevor Jones was retained by BC Wild to critically assess the province's MAA methodology and its application in various studies. As noted earlier, he concludes that the methodology is generally sound, despite finding that

> ...the bad news comes in the application of the methodology. First, it's hard to quantify "intangibles" like preservation value of wilderness or "semi-tangibles" like the value of a day of hiking.

> Second...poor assumptions or careless selection of the economic factors have plagued the recent analyses reviewed in this report (Jones, 1994:1).

If the methodology depends upon the quantification of values that are difficult or impossible to quantify, it seems more reasonable to conclude that the methodology itself needs to be revisited, yet Jones does not come to this conclusion. Jones also does not examine how a stream of benefits derived from natural capital depletion should be adjusted to differentiate between true income and depletion. Instead, Jones focuses on specific assumptions used in various MAA studies, and shows a pattern which suggests a systematic failure to fully consider the ecological ramifications of resource extraction regimes and the economic consequences of ecological deterioration. Amongst his observations:

- for the Spruce Lake analysis, the base case involved a rate of cut whereby 3/4 of all merchantable timber would be depleted in the first 10 years.
- cutting rates were excessive for Kispiox, Clayoquot Sound, Fort Nelson, and Northern Kalum--the latter two studies involved AAC rates which so greatly exceeded sustainable cutting rates that they "did not merit detailed critiques;"
- excessive factors were used for logging-related jobs per 1000 m^3, and multipliers for non-direct employment were too high; and
- non-commercial values "were given little more than lip service" (Jones, 1994).

Jones' analysis also supports the conclusion that extraction regimes involve high levels of natural capital depletion. It also suggests that if BC MAA is eventually set on a sounder theoretical footing that takes natural capital depletion into account in the analysis of economic benefits, assumptions and factors buried in the analysis (e.g. the AAC, employment factors, multipliers) will need to be carefully scrutinized.

4.8 Conclusions

From this brief review of multiple accounts analysis and resource appraisal conducted to support land use and timber allocation decisions in BC, it is evident that such studies involve many shortcomings, including the following which are directly relevant to the focus of this research study.

The studies assume that status quo policies produce an outcome which is ecologically achievable, despite much evidence to the contrary. Falldown is often projected to be five or more decades from present, yet timber supply shortages loom or have already occurred in many regions. Managed forest stands are expected to produce high volumes of timber, despite evidence that simplified ecosystems undergo severe ecological stress without the resilience to adapt to such stress, and the result is often significant reductions in long term productivity. There is limited attention paid to risk, uncertainty, or the implications of the precautionary principle. Resource appraisal studies prepared to support MAA have been shown to be of limited reliability or usefulness.

The studies do not account for the failure to maintain natural capital intact. The studies are therefore inconsistent with principles of honest economic reporting. The studies also fail to account for declining resource quality under a timber management regime which purposefully reduces the average age of timber extracted.

MAA studies are also often misleading in that they show that a given scenario results in an improvement of environmental quality if it degrades the environment less seriously or more slowly than the (usually ecologically non-viable) baseline scenario. Instead, environmental quality should be assessed on the basis of the degree to which it respects the requirements of maintaining ecosystem health. By adopting an impact assessment methodology, analysts face the difficult task of predicting ecological conditions 200 years in the future for scenarios involving widespread and rapid ecological manipulation and simplification. This places the analysts in a framework unsuitable for inherently complex systems where uncertainties, emergent properties, long time delays and surprise are prevalent and where cause-effect relationships are difficult or impossible to establish (Holmberg, 1995:4). The task is further complicated by the minimal resources assigned to the task. A more realistic approach would be to establish the prerequisites for maintaining ecosystem health and to identify ecological thresholds, and to provide an assessment of the likely and probable range of consequences of failing to maintain ecosystem health or of exceeding thresholds.

The studies reviewed comprehensively document the revenue flows generated by industrial forestry, but ignore or are less thorough in documenting the expenses, such as the expense of running the Ministry of Forests or the grants, subsidies or tax incentives provided to industry, which often overwhelm the economic value generated by the industry (Mascall, 1997), or the expenses passed on to other ministries or levels of government such as for highways or water purification. At the same time, the studies do not consider whether the government is capturing adequate rent for the use of its resource, how rent capture could be increased to compensate for a lower AAC, how the resource could be better utilized, or how employment per 1000 m^3 extracted could be increased if the AAC declines. At present most multiple accounts studies fail to incorporate an economic efficiency account, and therefore fail to meet provincial MAA guidelines. If the economic efficiency account is to be useful, it should attempt to incorporate environmental costs and benefits of various scenarios, but no examples of this being done were found. Because of the extensive forestry industry statistics gathered by government, analysts are able to manipulate and project the effects on the timber industry of alternate rates of extraction. In contrast, other sectors, due to lack of data, are often assessed qualitatively, usually without influencing bottom-line economic figures.

Transition from the current base case scenario to alternative scenarios is analyzed as occurring without time lags, which fails to allow for "lag effects" to be captured, often overstating the economic impacts of transition costs. It is assumed that technology remains constant, and all economic impacts are attributed to reduced harvest levels, rather than assigning some impacts to the continued rationalization and mechanization that industrial forestry promotes. Differences in land use allocation, forestry regimes, or AAC levels between various alternatives subject to analysis are typically fairly minor, especially when compared to an alternative that would satisfy advocates of ecosystem-based management and would maintain natural capital intact. None of the alternatives presented maintains natural capital intact. The participants in LRMP and other such processes are therefore not being provided with true alternatives; instead, they are presented with minor variations on a theme. Rather than seeking to pursue societal objectives, namely sustainability, and then seeing to find ways to make transition occur with the least possible disruption, the studies focus on documenting the costs of change. As such, they may fail to identify mitigation strategies, they fail to consider whether the status quo is making a satisfactory contribution to individual and community well-being, and they may mislead communities and government into believing that tough decisions can be avoided.

Taken together, these problems result in a systematic bias against sustainability, and a failure to account for changes in the stock of natural capital. If analysts are to address this deficiency, they will need an appropriate methodology. Alternative methodologies will be discussed in Chapter 5, and one will be proposed for use in economic analysis of land use or timber allocation questions in BC. Until the government of BC adjusts required methodologies for MAA, and economic analysis, to account for natural capital, the use of

MAA to consider the implications of land use and timber allocation decisions biases decisions towards those options which involve high rates of timber extraction and deteriorating ecological conditions, over more sustainable alternatives.

Chapter 5: Incorporating Strong Sustainability into Economic Analysis

5.1 Chapter Overview

Chapter 4 demonstrated that the MAA framework used in BC does not explicitly take strong sustainability into account. In order to achieve strong sustainability, and to account for the benefits from resource extraction in a way that is consistent with the commonly accepted definition of income interpreted in a world close to ecological limits, MAA needs to be modified. This chapter sets out how this should be done, by breaking down the task into two components. The first component, which is the emphasis of this chapter, is to examine how economic analysis in a MAA framework should be modified to take into consideration the need for strong sustainability, and to account for the depletion of natural capital. The recommended means of accounting for natural capital depletion is developed following a review of how various authors have tackled this problem in the context of revisions to the System of National Accounts and in proposals to make project appraisal consistent with sustainability objectives. This review is included as Appendix 1 to this study and is briefly reported on in this chapter. The second component is to examine how the multiple accounts framework itself should be modified to ensure that both analysts and those who use the outputs from the analysis incorporate the requirements of strong sustainability into their analysis and deliberations.

5.2 Criteria for Assessing Proposals for Modifying Economic Analysis

Before reviewing the proposals to account for natural capital, criteria for assessing such proposals were also identified during a literature review. While it is desirable to use a method which is grounded in both economic and ecological theory and reality, such a method will not be of use if it is overly onerous or if it generates results the users of the analysis cannot comprehend or relate to. While it is important to minimize inconsistencies between theory and technique, in practice inconsistencies will remain, and it is important to examine the minimum requirements that a tool must meet, as well as to gain an understanding of what weaknesses will be acceptable. The criteria identified below are based both on comments scattered in the literature and on common sense. No one tool or technique is likely to satisfy all criteria. The analytic techniques should be:

> 1) Feasible: the analysis must not be unreasonably onerous for the analyst, either in terms of data requirements, or in terms of analytical requirements (e.g. extensive input/output modeling would require analytical capabilities beyond those likely to be applied).
>
> 2) Consistent: the modifications should be consistent with both economic and ecological knowledge, and the requirement to address strong sustainability.
>
> 3) Reasonable: the modifications should appear reasonable to the layperson, be grounded in everyday concepts if possible, and be relevant to arguments for increased sustainability.
>
> 4) Provide correct signals: the modifications should provide correct signals as to the implications of choosing unsustainable or sustainable resource extraction regimes (UN 1993:3; Repetto, 1989:6; Daily, G. et al, 1996). The signals should make clear:
>
> > i) the dependence of economic activity on ecosystem health;

ii) how extraction at sustainable levels provides for the long term enjoyment of economic benefits derived from natural capital;

iii) how extraction at rates (or in a manner) that are not sustainable is risky, and will result in future reductions in the level of environmental functions, that the stream of benefits generated by such extraction will only be temporary, that the costs are likely to be significant, and that such extraction regimes may occur largely at the expense of future generations;

iv) how investments in natural capital through deferred extraction of renewable resources or restoration activities increases the value of the stock of natural capital, the flows that the stock can generate, and the level of environmental service that the stock is able to provide; and

v) how conversion from natural capital to cultivated capital (e.g. from old growth forest to tree plantation) represents conversion from one type of capital to another, and, when done on a large scale, is inconsistent with strong sustainability.

5) Express tradeoffs: the modifications must capture the tradeoffs amongst various uses of natural capital and the functions that natural capital is able to support under different management regimes (UN, 1993:13).

6) Express economic fitness in the context of limits: the modifications should help illuminate the relative fitness or capacity of the economy to react to stress or the imposition of limits (Gustafson and Lonergan, 1994:54).

7) Make causal linkages: the modifications should help illuminate causal linkages in order to assist in diagnosis of environment-economy linkages (Gustafson and Lonergan, 1994:54).

8) Assess management efforts: the modifications should help in assessment of management efforts and their effectiveness in bringing the economy closer to a desired state (Gelinas and Slaats, 1989, cited in Gustafson and Lonergan, 1994:54).

9) Focus debate: the modifications should focus the debate on the important issues (e.g. what is sustainable forestry, how can we ensure that society respects ecological limits, how can we adjust incentives, institutions and property rights, what is the best transition strategy) rather than prompting disputes over the finer points of methodology (Dasgupta et al., 1995:133).

10) Support democratic institutions: the modifications should not appear to favour the replacement of social and political decision-making processes with decisions based solely on the outcome of analysis, but rather should broadly involve society as participants in goal setting, clarifying values, and reviewing and interpreting the analysis (Costanza and Folke, 1997).

11) Take political-economic power and institutions into account: the modifications need to be sufficiently compatible with current political-economic power and institutions to allow the use of proposed methodologies and public debate of the results of the analysis, without being so watered down as to prove

ineffective as an interim inducement toward strong sustainability (Lux and Lutz, 1979; de Graaf et al., 1996:205; Costanza and Folke, 1997:59).

Before proceeding further, it is useful to point out that there are two main approaches to incorporating strong sustainability into economic analysis: the constraint approach and the evaluative approach. With the constraint approach, strong sustainability is set as a constraint which all projects must pass. Those projects which do not meet this requirement are eliminated from further consideration, and therefore the economic analyst's role is to help identify projects with the greatest economic benefit amongst strongly sustainable alternatives. Since all such proposals will maintain natural capital intact, there is no need to account for natural capital depletion. This constraint approach would be the most direct and effective means of ensuring that projects or resource extraction regimes respect strong sustainability. However, it is unlikely to be accepted at present (so few current or proposed activities in industrial societies would meet the strong sustainability criterion). Advocating the constraint approach is thus politically naive and does not, given current social and political realities, meet the objectives outlined above.

With the evaluative approach, strong sustainability is not set as a constraint, but rather any divergence from strong sustainability affects the outcome of the analysis. This study will use the evaluative approach, and will suggest that the failure to achieve sustainability should be evaluated economically, on the basis of two adjustments:

- the outputs of economic analysis must reflect any significant consumption of natural capital by taking into account changes in natural capital stocks and the associated streams of benefits that such stocks provide; and

- the cost of ecological degradation that occurs as a result of the depletion of natural capital needs to be reflected in the analysis.

At first glance, it may appear that modifying economic analysis to account for changes in natural capital stock, while at the same time incorporating the costs of ecological deterioration due to natural capital depletion, involves double counting. Indeed, the analyst will have to be cautious to avoid double counting. But two distinct phenomena are involved, and the difficulty is related to the problems that arise when one applies economic concepts to the natural world. Further elaboration is necessary to explain why the economist must take both the above-noted values into account.

Consider the following analogy: a privately-owned canal raises ships through a series of locks. The floodgates are regularly maintained, planks and beams are replaced as needed, such that the locks are perpetually renewed. One day, the canal changes hands, and the new owners seek to cut costs by foregoing expenditures on maintenance. The economist documents how, year by year, the new owners are allowing capital depreciation to occur, eating into the canal's capital. The value of the canal declines by the amount that it would take to restore or replace the floodgates. If the economist fails to look beyond such capital consumption, an unpleasant surprise may take place. One day, the floodgates, now weakened, simply burst, damaging ships and properties along the canal. Not only must the gates be replaced, but compensation must be paid out. The astute economist would have anticipated such costs. A more dramatic example, and one which reflects our environmental predicament, would be the failure to conduct required maintenance of a nuclear power plant, where the damage to surrounding properties may cost much more than the initial capital investment.

Returning to the case of natural capital, it is one thing to liquidate a stand of 500 year-old cedar, converting natural capital into financial capital. Clearly, from an income perspective, such an action does not involve generating income, but rather asset substitution. Once liquidated, old growth forests cannot be liquidated a second time (except over a very long time frame). If rights to timber confer no other obligations to the owner of such rights, then only capital depletion needs to be taken into account. But from a societal perspective, the implications of depleting natural capital can be much greater. For instance, if liquidating old growth in watersheds and on steep slopes leads to mass failure, ruining a village's water supply, from a societal perspective two separate economic results have to be taken into account: old growth has been liquidated and the village's water supply has been damaged.

5.3 Review of Techniques for Accounting for Natural Capital

By reviewing the literature on greening the national accounts, as well as the literature on incorporating sustainability objectives into project appraisal, a number of approaches were identified to account for natural capital. Some of these approaches would have to be modified to be applied at the project level, or to carry out economic analysis of forest land use options. Appendix 1 provides an assessment of the relative strengths and weaknesses of the various approaches, in order to provide background material for the proposed method advocated in this chapter and applied in Chapter 6.

Table 5.1 Approaches to Accounting for Natural Capital Depletion

Approach	Overview of Technique	Strengths	Weaknesses
Bioeconomic optimization models	Use mathematical models to identify optimal resource management regimes.	Mainstream credibility; avoid economically irrational resource exploitation.	Ecological linkages often poorly specified or omitted from models; typically takes perspective of a single resource owner; seeks to optimize on behalf of present owner or generation, rather than recognizing that the decision is ultimately about allocation across generations; mathematical models may poorly model future ecological conditions.
Change in productivity	Calculate opportunity cost of depleting natural capital.	Relative simplicity, ability to refer to market prices.	Difficulty of estimating change in productivity in many circumstances or determining cause-effect relationships; takes perspective of single resource user rather than that of society dependent on a diverse ecological services, thereby underestimating value of natural capital.
Replacement cost/ Shadow project/ Environmental annuity	Calculate cost of replacing depleted natural capital.	Based upon commonly accepted principles, presumption that natural capital should be maintained intact.	Replacements used to derive costs often poor substitutes for natural capital; difficulty in dealing with irreplaceable natural capital. Often generates near-infinite values for natural capital.
User cost/El Serafy method	Convert revenue stream into a capital fund to generate equivalent annual payments once resource is depleted.	Accepted practice in oil and mining industry; relatively simple.	Not suitable for renewable resources; presumption of substitutability; takes perspective of single resource user rather than that of society dependent on a diverse ecological services, thereby underestimating value of natural capital.
Depreciation/ Net price	Multiply stock level by net price (value of natural resource less cost of extraction) and take changes in stock levels over accounting period into account.	Similarities to accounting practices for manufactured capital.	Signal contaminated with stock revaluations and price changes leading to perverse results; inconsistencies with economist's definition of income; restricted to marketed resources; takes perspective of single resource user rather than that of society dependent on a diverse ecological services, thereby underestimating value of natural capital.
Hueting's Sustainability Standard/ Avoidance Cost/ Maintenance Cost	Estimate costs of modifying economic activity so as to meet sustainability standards.	Compatible with strong sustainability perspective; provides useful signals to society on current divergence from sustainability.	Difficulty of estimating cost of meeting sustainability standard; possibility of perverse results providing wrong signal; arbitrary and impractical; extensive research often required.

Table 5.1. (continued)

Approach	Overview of Technique	Strengths	Weaknesses
Generational ecological debt	Sum of restoration expenses (where restoration is cost-effective) and social costs of remaining, unrestored damages.	Creative approach to difficult problem; signal conducive to strong sustainability; could apply standard factors based on case studies.	Requires extensive research; values for natural capital may be so high that results will be rejected.
Ecosystem-economy linkages	Model the linkages between the economy and ecosystems so that economic consequences of ecological degradation become clear.	Provides better understanding of ecological and economic consequences of unsustainable economic activity.	Requires extensive modelling; difficulty establishing cause-effect relationships.
Valuation of ecosystem services used in Daly and Cobb's Index of Sustainable Economic Welfare	Value depleted natural capital on basis of value of lost flow of services, taking the cumulative loss and marginal costs into account.	Takes cumulative loss of service and marginal effects into account.	Depends on other valuation techniques to put price on depleted natural capital.
Contingent valuation/ Hedonic pricing	Construct artificial markets for unmarketed ecological goods and services.	Has been used in wide variety of circumstances.	Inconsistencies; technique extensively criticized; arbitrary results; results depend heavily on how questions are framed; results highly influenced by current distribution of wealth; requires extensive surveys; philosophical inconsistencies and moral implications that are difficult to accept.
Stumpage and tenure-based valuations	Estimate value of asset from the capitalized value of future stumpage revenues or on the basis of observed prices for tenure rights.	Has been used in BC forestry; simple to apply.	Takes perspective of single resource user rather than that of society dependent on diverse ecological services, thereby underestimating value of natural capital; values observed in BC markets highly distorted.
No adjustments necessary	Market values already take natural capital depletion into account.	Simplicity: analyst is not required to do any adjustments.	Based on implausible assumptions. Does not provide any signals to direct efforts towards sustainability.

Table 5.1 Overview of approaches reviewed in Appendix 1 to account for the depletion of natural capital.

5.4 Recommended Approach to Account for the Depletion of Natural Capital

The review of approaches to accounting for the depletion of natural capital included in Appendix 1 has shown that none of the approaches appears to be particularly well-suited to recommend as a modification to current MAA practice in BC. For this reason, this subsection advocates a new approach, tentatively labeled the interest/depletion approach.[10]

The rationale behind this proposed approach is supported by reference to economic theory, by interpreting the implicit need in Hicks' definition of income to maintain capital intact in the context of a full world, and by reference to the social commitment to sustainable development. From the first perspective, all generations, if prudent, have a responsibility to maintain natural capital intact (unless the economy shrinks so much that human activity is well within natural limits). Resource extraction flows can therefore, in an economic analysis, be divided into strongly sustainable and unsustainable components, labeled as the interest and depletion components respectively. From the second perspective, each generation has an obligation to future generations to provide a level of natural capital that maintains ecological integrity or ecosystem health. Any extraction in excess of that which is ecologically sustainable implies that the present generation has benefited at the expense of future generations. Where there is commitment to strong sustainability such appropriation can be seen, in one sense, as an intergenerational taking, or as an ill-gotten gain. As argued in Chapter 3, there are very limited prospects for technology, ingenuity, or knowledge to offset the costs of allowing current levels of natural capital to drop further, except in very limited circumstances. Decisions on whether intergenerational equity can be satisfied through investments, chosen in accordance with given discount rates, or by

[10] A more intuitive label might be the income/depletion approach, since it is derived from a Hicksian definition of income. However, in a multiple accounts analysis one analyzes regional and provincial income, which would lead the analyst to divide this stream into "income" income and "depletion" income, resulting in confusion.

extension, through investments dictated by proper pricing of natural capital, represent, according to Norgaard,

> ...an inappropriate theoretical framing of the choices before us. Matters of equity should be treated as such. If we are concerned about the distribution of welfare across generations, then we should transfer wealth, not engage in inefficient investments. Transfer mechanisms might include setting aside natural resources, and protecting environments... (Norgaard, 1993:285).

Therefore, all benefits derived from extraction can be divided between those which can rightfully be appropriated by the current generation (the interest on natural capital) and those which should have belonged to future generations (the depletion of natural capital). Applying the Hicksian definition of income to natural capital in a full world, and the societal commitment to sustainability perspective, thus coalesce.

From this starting point, if the interest and depletion flows are conceived of as separate economic activities, the benefits derived from each flow could be tracked separately. From this starting point, jobs can be divided into interest and depletion jobs, income can be divided into interest and depletion income, and government revenue can be divided into interest and depletion revenue. In the economic efficiency account, any depletion benefits should be netted out, given that these benefits do not truly involve value added or production, but instead are based on natural capital consumption. Just as the proceeds from the consumption of an asset do not appear as a benefit in a financial appraisal, nor should a Cost-Benefit Analysis (CBA) within a MAA identify the depletion of natural capital as a benefit. (Chapter 6 will provide examples of the above approach).

Once a sustainable baseline scenario is identified, preferably by ecosystem-based planning but otherwise through resource appraisal, the technique proposed above is simple to apply. It is amenable to various levels of sophistication in the way it addresses ecosystem-economy linkages. In its simplest application, there is a strict boundary between resource extraction that is sustainable (harnessing the flow generated by the stock) and that which involves natural capital consumption (eating into the stock itself). A more sophisticated application would take into account the increasing seriousness of widening divergences from sustainability standards. For instance, if extraction exceeded the sustainable baseline by a factor of not more than, say, 20%, those benefits above the baseline appropriated by this generation could be "discounted" by a certain percentage in any economic analysis to reflect the fact that natural capital depletion may be relatively slight and that future generations are relatively unlikely to suffer a large drop in the availability of natural capital. If the baseline were exceeded by a factor of 100% or more, all benefits from extraction above the baseline would "not count" in economic analysis, or would at least be labeled as involving depletion to show their undesirable origins. For the purposes of this study, it will be assumed that there is a strict boundary between maintenance and depletion of natural capital.

The interest/depletion approach appeals to common sense and to notions of fairness: it is consistent with the concept of sustainability, and with accepted definitions of income reinterpreted in the light of current circumstances. Because it involves determining the ratio of sustainable to depleting economic activity, this approach provides a good indication as to what extent society must make changes in order to achieve sustainability, and thus it provides an appropriate signal. This assumes of course that the sustainable baseline is appropriately identified.

This appraisal is not without limitations of its own. Like other techniques reviewed in Appendix 1, it does not address the depletion of natural capital that does not directly support market activity, or the implications of reduced levels of ecological services, although it does suggest that the continuity of current economic benefits will be threatened as the depletion to interest ratio increases. It does not provide a sophisticated model of economic-ecosystem linkages, though sophistication in determining the requirements for maintaining natural capital intact would certainly aid in determining the interest/depletion ratio. Thus, while the interest/depletion approach is simplistic in its specification of economy-ecosystem interactions, this is not a fatal flaw. Economic analysis of forest use options in BC is supposed to take place in a MAA framework. A properly conducted MAA should document environmental degradation caused by aggressive resource extraction regimes. Where possible, the economic accounts should be adjusted to incorporate such costs. For instance, the economic efficiency account should include costs associated with degraded watersheds, landslides, topsoil loss, productivity reduction, species loss, and the decline in economic activity which depends on intact forest ecosystems.

The interest/depletion approach is recommended because it is feasible, consistent, reasonable to the layperson, because it provides appropriate signals, and because it is open to democratic involvement. It focuses debate on two key issues: 1) what is the sustainable baseline? and, 2) where benefit streams are shown to involve high levels of depletion, how can society make the transition from depending on depletion to depending only on the interest?

5.5 Modifying MAA to Take into Account Strong Sustainability

In Chapter 4, a number of deficiencies were identified in both the way that MAA is typically applied in BC, and in the MAA framework itself. Two main problem areas were identified. The first, addressed in the previous subsection, was a failure to account for the requirements of strong sustainability. The second was a lack of integration between economic and environmental accounts. With the lack of integration, the environmental accounts could show that a given scenario would produce serious and irreversible environmental degradation, while the economics accounts suggested that the resource extraction regime which was the source of such degradation could be maintained indefinitely. To correct for this shortcoming, and others related to it, the overall MAA framework needs to be examined.

5.5.1 Environmental Accounts

In the existing framework, impacts on the environment are contained within the environmental values account, focused mainly on non-commercial resource use and resource attributes, divided into use-related values and existence-related values (Province of BC, 1993:5). This nomenclature unrealistically portrays the environment as an amenity, rather than as a prerequisite for life and the basis for economic activity. Degradation in such a scheme is only significant where it impacts human recreational use or appreciation. To address this shortcoming, it is proposed that both the regional and provincial environmental values account be replaced with an equivalent Ecological Integrity and Natural Capital account (for an overview of the proposed MAA framework, see tables 5.2 Environmental accounts, 5.3 Economic accounts, 5.4 Other accounts). The regional account would focus on those characteristics and effects best described as regional in character, while the provincial account would take a provincial perspective. Before explaining the rationale behind the component sub-accounts of the Ecological Integrity and Natural Capital account, a brief explanation of the recommended approach toward the evaluation of ecological function and change is required.

Given the difficulty of making cause-effect predictions about future ecological states, it is preferable to separate the task into three parts. The first is to begin early in the causal chain and identify as many requirements of strong sustainability as possible, in the form of principles, limits, landscape and stand level requirements. The second is to document how a given regime violates or exceeds any of these principles, limits, or requirements. The third is to attempt the much more difficult task of identifying the ecological consequences of stressing the ecosystem by violating such requirements. Because many effects cannot be predicted, it is essential that the analysis not depend on establishing cause-effect relationships or consequences, though an ability to make such predictions would contribute to the analysis. For this reason, the proposed overall approach to MAA and to the new environmental account provides for this separation.

The requirements of strong sustainability would be identified in as much detail as possible prior to undertaking MAA and documented as a chapter within a MAA that precedes and sets the ecological context for the overall analysis. As proposed in Chapter 3, this involves determining the conditions under which a resource extraction regime will have a good *a priori* chance of maintaining ecological productivity, integrity and diversity, because the extraction regime respects principles taken from forest ecology, conservation biology, and landscape ecology. Of course, a variety of such regimes may be feasible, the simplest of which may involve little or no resource extraction. For the analysis which follows, it is essential to identify a resource extraction regime which provides the highest level of economic benefit that is consistent with respecting the requirements of strong sustainability and maintaining a precautionary margin to cope with uncertainty and surprise. The requirements of strong sustainability are defined both at the landscape level and at the stand level, based on current conditions. In the context of landscape-level plan, much of the landscape will be maintained uncut. At the stand level, many of the trees will not be extracted so that required structure and function are maintained.

Once the requirements for strong sustainability have been specified, multiple accounts analysis can begin, starting with the environmental account. The first sub-account within the environmental account would identify divergences from the requirements of strong sustainability. The second sub-account would document the ecological changes that are likely or could be expected as a result of failing to stay within the bounds of strong sustainability. Much of the remainder of the analysis within a MAA would refer back to these key sections.

Proposed Environmental Account

Account	Sub-Account	Explanation
1. Environmental Account	1.1 Divergence from Strong Sustainability (Regional and Provincial)	This sub-account compares the resource extraction and land use regimes against the ecological requirements for strong sustainability. This sub-account is essential so that other portions of the MAA may take natural capital depletion into account.
	1.2 Ecological Change (Regional and Provincial)	This sub-account documents and evaluates changes in ecosystem integrity, in essential ecological functions, and in natural capital stocks and flows as a result of divergences from strong sustainability.
	1.3 Ecological Entitlements (Regional and Provincial)	This sub-account documents how a resource extraction regime and land-use scenario will change the access to ecological entitlements by various sectors of the population and by various economic interests.
	1.4 Environmental Values (Regional and Provincial)	This sub-account is similar to the BC MAA environmental values account in that it is intended to document how a given regime affects the ability of the population to enjoy and appreciate the environment. It does not, however, use an "existence value" framework, as this is superseded by subaccounts 1.1 and 1.2.

Table 5.2 Proposed Environmental Account for a revised MAA framework. Each sub-account is applied at the regional and provincial level. The divergence from strong sustainability and ecological change sub-accounts frame and influence the analysis of all other accounts. The requirements for strong sustainability need to be established prior to undertaking multiple accounts analysis by beginning early in the causal chain, rather than relying on the prediction of cause-effect relationships.

<u>Divergence from Strong Sustainability</u>: This sub-account compares the resource extraction and land use regimes against the ecological requirements for strong sustainability, and documents and evaluates each significant divergence. The divergence from strong sustainability sub-account is essential in order that other parts of the MAA may take into account any reduction in ecological integrity or depletion of natural capital that is likely to

be caused by the scenarios being evaluated. It will also assist in dividing the benefits of a given regime into interest (sustainable) and depletion (unsustainable) components.

Ecological Change: This sub-account documents and evaluates the changes in ecosystem integrity, in essential ecological functions, and in natural capital stock and flows that are likely or possible (within the confines of operating in a context of uncertainty) as a result of the divergences from the requirements of strong sustainability identified in the previous sub-account. Such predictions are notoriously difficult. However, at the same time, certain predictions can be made with high levels of confidence. For instance, if most old growth habitat is removed or significantly fragmented, many old-growth dependent species are likely to be extirpated. If large woody debris is not retained, soil structure and function is likely to be diminished over the long term, as is site productivity. This sub-account also evaluates changes in natural capital stocks and flows that are of importance to the local and provincial economy. For instance, if increased forest ecosystem "brittleness" and soil compaction and degradation are expected, then consequent declines in stocks and flows of timber should be projected.

The ecological change account should also document defensive measures that will be necessary to compensate for environmental deterioration. For instance, if watershed logging is expected to negatively affect domestic water users, then the analysis should discuss which measures such users may have to take to maintain their access to water of equivalent flow and quality. If soil productivity is expected to decline, then measures that will be used or that may become necessary to compensate for the loss of productivity should be documented. This is an essential step to ensure that the economic efficiency and government revenue accounts take such reductions in future productivity and increase in defensive expenditures into account.

Ecological Entitlements: This sub-account is based on an argument made by Ruitenbeek (1996a) concerning the distribution of ecological entitlements. Because so many of the benefits provided by nature are outside of market transactions, it is relevant to examine how access to both ecological flows and services are changed by different resource extraction regimes. A given scenario may involve more jobs than another, but if the jobs are created by reducing ecological services formerly enjoyed by neighbors or by a given segment of the population, then these jobs may no longer appear so desirable. In forestry decisions in BC, the distribution of ecological entitlements is a key issue. Many argue that multinational corporations are given first priority and access to the landscape and resources, while First Nations, local communities and small businesses have little access to timber but feel the brunt of the ecological consequences (Burda et al., 1997:38-40). In the context of the Slocan Valley, a key concern is how resource extraction regimes will affect the entitlement of residents to pure, dependable water supplies.

Environmental Values: The existing MAA guidelines specify that the environmental values account should document how a given management regime influences, first, the use and enjoyment of the environment; and secondly, existence values, and the achievement of regional and provincial objectives. This framework unrealistically portrays the environment as an optional undertaking with limited consequences for quality of life. In the proposed framework, the initial task of identifying the requirements of strong sustainability, the new subaccounts described above (divergence, change and entitlements subaccounts) address the second half of the existing MAA equation in a more comprehensive manner. The proposed environmental values account would therefore focus on the first half of the equation, showing how a regime would affect enjoyment of the environment and perceptions of environmental quality.

5.5.2 Economic Accounts

While the existing economic accounts focus attention on direct, indirect and induced impacts in terms of jobs and income of a given scenario, a broader perspective is required in a context in which the desirability of properly accounting for natural capital depletion and a societal commitment to strong sustainability is acknowledged. The regional and provincial economic accounts are therefore divided into several sub-accounts.

Economic Consequences of Ecological Change: This sub-account captures the likely economic consequences of the ecological change expected as a result of a given scenario. By referring back to the ecological change sub-account, the analyst attempts to predict the economic consequences of such changes, so that these changes can later be expressed in terms of costs and benefits, jobs and income. Any economic activities that become non-viable as a result of ecological change should be documented, as should increases in expenditures required to compensate for the increased management inputs to maintain commodity production by brittle ecosystems.

Economic Benefits Analysis: This sub-account documents the jobs and income provided by a given regime, and divides these flows into interest and depletion components, in accordance with the extent to which natural capital is being maintained or depleted. This sub-account will be discussed in more detail in the following chapter.

Economic Equity: It is generally recognized that an equitable distribution of income is a prerequisite for sustainability or strong sustainability (WCED Commission, 1987:48; Robinson et al., 1990: 43; Ruitenbeek, 1996). It is relevant then to assess how a given resource extraction regime affects access to economic benefits, be it monetary or non-monetary, and the resultant distribution of wealth and income.

Proposed Economic Account

Account	Sub-accounts	Explanation
2. Economic	2.1 Economic Consequences of Environmental Change (Regional and Provincial)	This sub-account captures the likely economic consequences of ecological change as a result of a given scenario such as changes in the viability of given activities, the need for and type of defensive activities.
	2.2 Economic Benefits Analysis (Regional and Provincial)	This sub-account documents the jobs and income provided by a given regime, and divides these flows into interest and depletion components, according to the extent to which natural capital is being maintained or depleted.
	2.3 Economic Equity (Regional and Provincial)	This sub-account assesses how a given resource extraction regime affects access to economic benefits and the distribution of wealth and income.
	2.4 Feasibility of Transition (Regional and Provincial)	This sub-account requires that the analyst document how a given resource extraction regime enables or inhibits future transition towards a sustainable economy.
	2.5 Provincial Government Finances (Provincial)	This sub-account documents the effects of a scenario on provincial government revenue and expenditures. Revenues are divided into interest and depletion flows. Expenses, liabilities, and revenue forsaken from activities foreclosed by a given extraction regime are accounted for.
	2.6 Economic Efficiency (Provincial)	It is recommended that this sub-account be deleted due to: 1) philosophical, theoretical, and practical difficulties; 2) scale effects, the presence of pervasive externalities, and the tendency of CBA to be misapplied. If it is retained, two rough modifications are proposed, to include the costs entailed by ecological deterioration, and to not confuse capital depletion with income.

Table 5.3 Proposed economic account for revised MAA. The first sub-account ensures that the analysis pays attention to ecosystem-economy linkages, by requiring the analyst to assess the economic implications of changes expected in the environmental account. The extent to which benefits are dependent on maintenance or depletion of natural capital must be analyzed, an innovation also included in the government finances sub-account. The economic efficiency account is also made consistent with the understanding of income. Economic and environmental accounts are thereby closely integrated.

Feasibility of Transition: Given that no regions in BC can currently be considered to have ecologically sustainable economies, this new sub-account requires that the analyst document how a given resource extraction regime enables or inhibits future transition towards a sustainable regional economy, where the health of regional ecosystems is maintained.

Provincial Government Finances Sub-Account: The intent of the existing account is to document the effects of a scenario on provincial government revenue and expenditures. (This sub-account has no equivalent in the regional economic accounts.) However, in most MAAs to date, the revenue side is emphasized, particularly that revenue generated by the timber industry. Government subsidies, expenses involved in facilitating exploitation, and potential liabilities created by allowing the landscape to degrade are often either not documented or inadequately documented. Furthermore, the contribution of sectors of the economy whose viability is diminished by industrial forestry is often noted, but because detailed dollar figures are not available, these numbers stay outside of the analysis. Finally, it must be noted that a large proportion of the revenue generated by the timber industry is based on natural capital depletion. This represents a reduction in the value of the public resource, and hence should not be counted as revenue in the provincial books. Together, these omissions and shortcomings create an overly optimistic portrait of the timber industry's net contribution to provincial government finances.

There are therefore four key changes to this sub-account:

1) Divide revenue into interest and depletion flows: revenue received by government is broken down into revenue derived from sustainable extraction,

and revenue derived from natural capital depletion. The latter cannot be considered to be true revenue as it involves asset substitution.[11]

2) Incorporate expenses faced by government to enable a given resource extraction regime: all subsidies, forestry department expenses, or expenses faced by other departments associated with a given regime, should be documented and included in the final tally.

3) Account for foreclosed options: any changes in government revenue and expenses due to the fact that a given scenario would foreclose upon other economic activities should be documented to the extent possible.

4) Estimate potential liabilities: if an aggressive resource extraction regime is expected to result in environmental deterioration, potential liabilities faced by government should be included in the analysis. For instance, government now faces a substantial liability in planting sites logged prior to corporations being given responsibility for ensuring that cutblocks be restocked. More recently, government has had to provide significant amounts of funding to decommission and recontour poorly built and located logging roads.

It is understood that exhaustive analysis of all the above effects is unlikely to be feasible. What is needed, then, is comprehensive analysis, in which the analyst gathers supporting data, describes all significant effects, and provides best estimates of likely economic impacts.

[11] From a weak sustainability perspective, final government revenue could be defined as the sum of "interest" revenue plus the equalized annual return that could be expected were the "depletion" revenue invested in a heritage fund.

Economic Efficiency Sub-Account: This sub-account also only appears in the provincial economic accounts. As noted in Chapter 4, this sub-account is often omitted from the analysis despite the fact that this omission defeats the original rationale behind the development of MAA, which was to add other perspectives to economic efficiency. Yet this omission may in fact be salutary. There is evidence in the US that monetized cost-benefit tests may have adversely affected forest planning processes and the evaluation of forest plan alternatives (Iverson and Alston, 1993:98). Where the *ends* are *given*, efficiency analysis can contribute by identifying less or more efficient means of achieving the ends. However, where the *ends* themselves are in question, critics argue that there is little reason to conduct efficiency analysis as the comparisons between alternatives are unlikely to be meaningful, especially where the intent of one alternative is to isolate a desired feature from the market mechanism (Iverson and Alston, 1993:103; Adams, 1992; Bromley, 1990; Sagoff, 1988). Hence, if the societal decision is between cautious stewardship or aggressive extraction, comparing net present values between the two alternatives misses the point, as would the comparison of the net social benefits of allowing versus outlawing slavery. By privileging optimality arguments, economists make a value judgment and act as politicians while posing as scientists (Deblonde and van der Straaten, 1996:13-14).

There is also a technical point that affects the appropriateness of undertaking economic efficiency analysis in the context of forest land use or extraction regime decisions, or to address other questions with significant environmental consequences. It is essential to recall that applied welfare theory assumes no externalities. Cost-benefit analysis is only appropriate, therefore, when all externalities are addressed. In the CBA context, an externality is anything that distorts equilibrium prices. Thus, applications of CBA fail when:

- there are unaccounted-for "public goods" or "public bads" (e.g. commodities where one person's consumption does not deprive others of the possibility of consuming them, and where others cannot be excluded from enjoying them--the classic public goods being lighthouses and national defense--such that market incentives will not be sufficient to provide society with optimal quantities of the good unless the state intervenes);
- there are unaccounted-for environmental externalities (a producer or consumer imposes costs or benefits on third parties without compensation being paid for discomfort or charges being collected for increased welfare, such that too much of a good is produced or too little environmental enhancement provided); and
- if there are scale effects such that price adjustments are no longer marginal (this can occur when either the project is large relative to the economy, or when price adjustments necessary to account for public goods or environmental externalities are large enough that all other prices are likely to be distorted).

With this background in mind, the difficulty faced by the application of CBA to forest land use and extraction regime decisions becomes quite apparent. Any environmental externalities need to be fully priced. As we have seen in this chapter and in Appendix 1, environmental valuation is difficult except for the simplest, most narrowly defined problems. If the analyst does succeed in determining appropriate shadow prices to account for environmental externalities, they are likely to be so large as to distort all other prices. For instance, if costs for soil erosion, loss of biodiversity, water degradation, etc. were also shadow-priced, and a degradation tax imposed on any firm using industrial forestry techniques in Canada, the tax would likely be substantial, and given the size of the forest industry proportionate to the Canadian economy, a whole set of price adjustments would occur, such as the prices of new housing, paper products, and packaging increasing significantly, while unemployed timber workers would decrease spending and depress wages. These price effects would in turn affect prices in other sectors. Almost all prices might then need to be adjusted.

When provincial MAA guidelines require economic efficiency analysis, they neglect the conditions posited by the fundamental theorems of welfare economics. In most forestry decisions there are pervasive externalities. Furthermore, because of the size of the forest industry relative to the BC economy, the cumulative effects of land use and timber extraction decisions across the BC landscape are likely to have a significant economic influence. These decisions are affecting a large proportion of the landscape, basic ecosystem services and life support functions, and communities where a third or more of the economy is timber-dependent, while a significant proportion of the remaining economy can be characterized as "intact forest ecosystem" dependent (e.g. indigenous peoples, outfitters, farmers). Therefore, these decisions are likely to influence more than 2-3% of the overall economy--perhaps even as much as 10%. When a project approaches 10% of the scale of an economy, most development economists abandon CBA as an evaluative tool altogether (Ruitenbeek, personal communication, December 12, 1997).

Setting aside such technical problems, there is the related difficulty that most cost-benefit analysis is poorly performed. It is a difficult tool to apply correctly, and an extremely easy tool to misapply (see Drèze and Stern, 1987). Indeed, a review of World Bank project appraisals has shown that documentation of potential externalities is haphazard and inadequate, and that the studies have a marked tendency to overstate benefits (Barnes and Olivares, 1988, cited in van Pelt, 1993:127). Too many practitioners have inadequate technical background and skills.

With this background in mind, it is useful to ask whether economic efficiency analysis is appropriate for use in the type of circumstances where provincial MAA guidelines require that it be prepared, e.g. where scale effects are significant and there exist pervasive but difficult to price externalities. There are two responses to this situation: the “abandon it” school, and the “fix it” school. The authors of some of the most definitive texts in CBA, Jean Drèze and Nick Stern at the London School of Economics, have proposed that CBA should be abandoned in such circumstances because of all of the reasons mentioned above. Others seek to apply fixes which are often inconsistent with underlying welfare economic theory. Given the philosophical, ethical, theoretical, and practical difficulties which underlie CBA, my personal recommendation is that this tool should not be included in the multiple accounts analysis. It obfuscates more than it clarifies, it demands detailed analysis, the resources for which are unlikely to be made available, and it tends to be given unwarranted credibility by those who fail to appreciate its limitations.

If government insists that economic efficiency analysis be conducted, a couple of rough “fix it” modifications are proposed below to correct for the pervasive tendency to neglect natural capital depletion and environmental deterioration.

The following revisions to this account involve not so much a significant change in approach, but rather ensuring that application of cost-benefit analysis is more in keeping with the requirements of the welfare economics theory. Two main errors are currently commonly committed: many environmental costs are omitted from the analysis (de Groot, 1994:163), and benefits derived from natural capital consumption are erroneously analyzed as if they were income (Daly, 1994:33). Addressing first the issue of the costs of environmental degradation, if all economic benefits are included, while many costs of environmental damage from the activity being analyzed are not, the outcome will be skewed. The standard rule for CBA can be modified to explicitly require valuation of environmental damage, such that for a project to be efficient, it must satisfy the following criterion:

$$\Sigma_t \, d_t \, (B_t - C_t - E_t) > O$$

where d_t is the discount factor, B_t, C_t and E_t represent Benefits, Costs (not including environmental damage), and Environmental damage in period t respectively (Tisdell, 1992:123). The advantages of specifying that costs be broken into economic and environmental costs is that the analyst is required to document the costs he or she identified in each category. No change in theory is involved: costs have been divided into two categories to ensure that they are more exhaustively calculated.

Addressing now the matter of accounting for natural capital depletion in efficiency analysis, benefits which are derived from natural capital depletion need to be adjusted to ensure that they involve value-added and not capital consumption. Two ways to perform this adjustment present themselves. The first is to take account of the opportunity cost of depleting natural capital, the opportunities that one forgoes as a result of the extraction regime. This would involve calculating those economic benefits net of costs that could have been enjoyed had natural capital been maintained intact. Many of these benefits could only be enjoyed by future generations, and discounting will quickly make their influence disappear from the analysis, so this approach is not very satisfactory. From the Hicksian perspective the analyst can net out those benefits, or at least a proportion of the benefits, which are derived from natural capital consumption, as they involve asset liquidation and not income or value-added. The economic efficiency test becomes:

$$\Sigma_t \, d_t \, (B_t \, \frac{I_t}{T_t} - C_t - E_t) > 0$$

where $\frac{I_t}{T_t}$ is the ratio of sustainable to total extraction.

The proposal outlined above is intended to directly, though roughly, ensure that environmental costs get their due on the economic efficiency scales, such that the reading more accurately reflects the intent behind the efficiency criterion, e.g., the weighing of *all* costs and benefits. Otherwise, CBA is seen and promoted as a tool which impartially balances all costs and benefits, while it is rarely recognized that the operator is seldom able to even find the items that are to be weighed on the cost side of the scale, leading CBA studies to be systematically overoptimistic (van Pelt, 1993:63). As noted earlier, though, the recommendation advanced in this study is that the economic efficiency account be abandoned in its entirety.

5.5.3 Community Account

Currently, the community characteristics account has a conservative influence on policy. The emphasis of this account is on community stability, stability being based on maintaining jobs, income levels and present lifestyles. These benefits are currently supported by high rates of resource extraction, even if these lifestyles are likely to be unsustainable. Although detailed review of this account, and proposals for its revision, are beyond the scope of this study, a few comments can be made. By stressing the maintenance of current job levels as a means of ensuring stability, a false sense of security is created. While current policy may call for continued high rates of extraction, on-the-ground reality cannot be manipulated beyond nature's limits for more than a short time frame. If exploitation is too aggressive or poorly carried out, future resource crashes are inevitable, with economic consequences which will be felt at the community level. Rather than providing for an orderly transition, the current emphasis on stability will likely result in temporary stability followed by rapid change and hardship. This account then needs to be more closely linked with ecological reality. Furthermore, the objective of sustainable development is not to sustain unjust, inequitable or unsustainable social practices and institutions, but to nurture and sustain socio-political practices that foster cultural and ecological sustainability (Robinson et al., 1990:38). For this account to usefully contribute to the long term well-being of the community, community viability and quality of life need to be considered in the context of the requirements for strong sustainability. However, specific recommendations on how this could be done are beyond the scope of this study.

Other Accounts

Account	Sub-accounts	Explanation
3. Community Account		This account examines the potential for a proposed extraction regime to increase or diminish both social and ecological sustainability; community viability and quality of life are considered in the context of the requirements for strong sustainability.
4. Specific Aboriginal Community Concerns		This account lies beyond the scope of the present study; its appropriateness for MAA is questionable, as First Nations often prefer not to participate in land use planning processes, and analysts typically lack the background to meaningfully address First Nations concerns.
5. National and Global Account	5.1 Sustainability	This sub-account examines in what way the propose resource extraction or land use regime adds to or subtracts from the prospects for national or global sustainability.
	5.2 Effect on Equity	This sub-account examines how a given scenario increases or decreases equity between BC and regions of the world where poverty is endemic.

Table 5.4 Other accounts in the revised MAA. This study has not focussed on the Community and Specific Aboriginal Community Concerns accounts. A new National and Global account is proposed to address the effects of local resource management regimes on broader-scale sustainability and equity.

5.5.4 Specific Aboriginal Community Concerns

Although critique of this account is clearly beyond the scope of this study, from my personal experience working with First Nations, I would recommend eliminating this account. BC MAA studies reviewed in the course of this research have had very weak sections on aboriginal concerns. This is not surprising. First Nations have often preferred to boycott land and resource use planning processes, and studies such as MAA, as they view their position as not just that of another stakeholder, but rather as that of a sovereign nation or at least an autonomous order of government within the federation. Analysts preparing a MAA typically have neither the background nor the expertise to meaningfully address "aboriginal community concerns." Furthermore, tenure and resource access arrangements set up to facilitate industrial timber extraction are fundamentally at odds with the interests of First Nations and their long-standing relationship with the land.

In my opinion it is not appropriate to attempt to address such fundamental issues in a multiple accounts analysis. More appropriate would be respectful, government-to-government negotiations aimed at providing First Nations with a sufficient landbase to ensure the viability of their communities, and aimed at signing co-management agreements for much of the remaining land base (see also Burda et al., 1997:77-84; Royal Commission on Aboriginal Peoples, 1996; Supreme Court of Canada December 11, 1997 judgment in the Delgamuukw v. British Columbia appeal).

5.5.5 National and Global Account

From an income perspective, it is not obvious how to make a compelling argument that the province has a responsibility to look beyond the maintenance of natural capital in its own backyard, and to examine instead how its resource management decisions influence natural capital nationally and internationally. From a sustainability perspective, the need for such consideration was well recognized by the Brundtland Commission, as evidenced by the title of its report, Our Common Future, and by explicit reference to interdependence (WCED, 1987:46). Interdependence ranges from universal dependence on a protective ozone layer, to the more subtle and unpredictable cumulative effects on the biosphere of innumerable local land use decisions such as conversion of small patches of forest to cropland (Gardner, 1997:54-59). There is also caution required to ensure that prospects for local sustainability are not increased by decreasing prospects for global sustainability (Wackernagel et al., 1997). To acknowledge this responsibility towards the common good, as well as a common sense imperative to seek to maintain the health of any system on whose survival we ourselves depend, two sub-accounts are proposed to examine national and global sustainability. The first is a sustainability sub-account: in what way does the resource extraction and land use regime add to or subtract from the prospects for national or global sustainability? The second sub-account examines how a given scenario increases or decreases equity between BC and regions of the world where poverty is endemic.

It may seem that to require that MAA include an account which so expands its perspective or broadens its accounting stance is overly demanding. However, this analysis should not require large amounts of time. The intent is to improve the prospects for a consideration of global sustainability and equity when local decisions are being debated and made. There is of course a danger that this section of the analysis would be made up of trivial analysis or of statements of good intent devoid of substance. As well, it may be difficult to assess how two fairly similar extraction regimes would differ in their global sustainability or equity effects. Nevertheless, forcing at least passing attention to the question is useful (as becomes obvious in trans-boundary settings).

5.6. Implications of the Proposed Revisions to MAA

By means of the above revisions, which account both for natural capital depletion and for the requirements of strong sustainability, prospects are improved for MAA in BC supporting a long term ecological perspective. If these changes are rigorously applied, participants in resource and land use decision-making will be more likely to recognize the serious consequences entailed by current resource extraction, and the difficult nature of the social and economic transition required.[12] If decisions are made on the basis of this analysis, to make serious progress toward strong sustainability and a consistent application of the Hicksian definition of income interpreted in a full world, no doubt hardships will be experienced. Yet these hardships, while not to be underestimated, will likely pale in comparison to those that nature will impose once the natural capital account is depleted beyond critical and irreversible thresholds. In this latter instance, transition will also occur, but in a context of surprise and reduced options. This outcome is likely to result in lowered levels of human well-being.

The proposed packages of revisions require an interdisciplinary stance. Indeed, in passages in the chapter referring to "the analyst," a more accurate wording would be "the team of analysts." The economist cannot proceed without the contributions of forest ecologists, wildlife biologists, soil scientists, hydrologists: in previous applications of MAA this was also true, to a lesser extent, because the economist typically had to consult natural resource managers in order to write up the environmental values account. In contrast, under the proposals advanced in this chapter, the economist needs to consult these other professionals in order both to understand the viability of future economic paths, and to be able to differentiate between interest flows and consumption of natural capital stocks. Furthermore, a study carried out under such a scheme is no longer the domain of experts whose opinions are beyond question; rather, the analysis itself becomes part of the public discussion, values are explicitly stated, and the values of both analysts and public are expected to change as implications and results emerge from the analysis (Funtowicz and Ravetz, 1991; Costanza and Folke, 1997:58).

As noted earlier, multiple accounts analysis originated partly because it was realized that there were goals other than efficiency which society sought to pursue. In particular, it was

[12] Of course, there may be better ways to achieve this recognition than to use a revised MAA methodology.

recognized that economic efficiency analysis tended to neglect what were seen at the time as natural resource conservation and environmental quality issues. A significant source of this neglect was the pre-analytic vision (Daly, 1992b:xi-xiv) and lack of ecological grounding within neoclassical and welfare economics (Prugh, 1995:Chapter 1; Daly, 1992b:2-13). As economic analysis draws increasingly upon insights from ecological economics, the need for a multiple accounts approach may well diminish. Concern for ecological integrity becomes the starting point of ecological-economic analysis, rather than an inadequately conceived add-on. Hicks' admonition that capital consumption should be recognized is expanded to ensure that the economist accounts for natural capital consumption as well. Over the interim, the above changes make economic analysis more consistent with both the requirements of a social commitment to sustainability and of conservative economic theory interpreted in the current ecological context. In the next chapter, a case study is used to examine the feasibility and implications of the proposed revisions used to account for natural capital depletion.

Chapter 6: Applying the Interest/Depletion Approach

6.1 Chapter Overview

The focus of this chapter is to contrast economic analysis of forest use options as conventionally carried out by the Ministry of Forests with the methodology recommended in Chapter 5 to account for the depletion of natural capital. By referring to concrete examples, the usefulness of this new methodology is put to the test.

As noted in Chapter 5, limited staff and financial resources are available to carry out multiple accounts analysis of land use and timber extraction scenarios in BC. For this reason, if the proposed methodology is to be applied, it must be feasible to carry it out within these constraints. If it is to be useful, it must help to reframe the debate, moving from "what (jobs, wages, government revenue) will be lost when we move closer to sustainability and how much sustainability can we afford," to "what level of ecosystem function is necessary for sustainability, and what proportion of economic activity is therefore unsustainable; how much degradation will we accept, and what are its costs; and how can we make the transition to a more sustainable economy?"

As noted in Chapter 2, the examples used to illustrate the proposed methodology for accounting for natural capital will be from the Slocan Valley and from the region within which it is situated, the area covered by the Kootenay-Boundary Land Use Plan, which is based on the boundaries of Ministry of Forests' Nelson Forest Region. As SFF has only done an ecosystem-based plan at the level of the Slocan Valley, while most Ministry of Forests planning and analysis is done at a more aggregated level, it will be necessary to make various estimates by scaling data from either the KBLUP or the Arrow TSA to the smaller area of the Slocan Valley, and vice versa. This will require making certain adjustments or assumptions, many of which a more detailed study would be able to avoid.

This problem illustrates a general difficulty in all attempts to apply ecosystem-based management: the fact that ecosystem boundaries and administrative boundaries rarely coincide. These shortcomings do not significantly detract from the overall goal of this chapter: to assess the proposed approach incorporating into economic analysis the principle that, in income determination, natural capital should be maintained intact.

6.2 Ministry of Forests Economic Analysis of the Implementation Strategy

In March, 1995, the government of BC announced its decisions regarding the Kootenay-Boundary Land Use Plan. In October, 1996, the Kootenay Inter-Agency Management Committee (IAMC) released a draft implementation strategy (KBLUP-IS), which contains the technical work necessary to implement the land use plan. Included as part of this strategy was a multiple accounts analysis of the impact of reductions in the AAC (required to implement the land use plan). The next task in this study is to review critically the economic portion of this analysis, and how it addressed the depletion of natural capital involved in the KBLUP-IS, in order to compare the ministry's result with that obtained using the interest/depletion approach.

6.2.1 Base Case Scenario Used for the Analysis

The base case scenario used to evaluate the KBLUP-IS is based on a continuation of status quo output, reflecting the annual allowable cut in 1996 of 5.5 million cubic metres, which is essentially equivalent to the average aggregate extraction volume over the period 1991-1995 of 5.6 million cubic metres (ARA 1996:17). The MAA provides details concerning the region's existing timber industry. Current timber extraction and processing levels (which are boosted by approximately 1 000 000 cubic metres of timber from private lands, and imports of timber from outside of the area) are estimated to provide 8550 person years of employment, and an aggregate wage of $360 million. With the expected AAC reduction of 9%, the report estimates that 460 to 560 person years of employment are at risk. On a job-per-cubic-metre basis, this works out to 1.1 job per 1000 cubic metres at risk. While the analysis notes that this job loss will result in indirect and induced impacts, these impacts are not analyzed and no multipliers are provided, despite these being requirements of the MAA guidelines (ARA, 1996:29). It is noted that this base case will result in substantial ecological deterioration, including high to very high risk to biodiversity, poor regional connectivity, very high risk to caribou habitat, high to very high risk to grizzly habitat, high to very high risk to ungulate winter range, and high to very high risk to fisheries populations (ARA 1996:14-15). It is clear, then, that natural capital would be depleted by status quo management; the overall feasibility of such an extraction regime is questionable as ecological decline may hinder achievement of timber production targets. However, the MAA does not question the viability of resource flows projected in the base case, nor does it address the impact of falldown.

6.2.2 MAA of the KBLUP-IS

As a result of implementing the KBLUP, a 9% reduction in the AAC is expected, from 5.5 to 5.0 million cubic metres, until falldown (ARA, 1996:22). This is the scenario subject to economic analysis. The actual timber harvest profile until falldown is not documented in the MAA. Across the province, various resource management measures are being investigated as a possible means of mitigating falldown. The intent is to determine how the timber productivity of the forest land base could be improved through fertilization, tree improvement, forest health programs, cover conversion, and timber extraction from problem forest types (Fibre Targets Task Group, 1997:14). For reasons noted in Chapter

3, such measures may not achieve desired results, nor are they consistent with maintaining natural capital intact; they are also expensive.

Impacts on government revenue are estimated by taking provincial average values of taxes paid per 1000 m^3 of wood cut, and multiplying these values by the expected reduction in the AAC.[13]

A number of criticisms can be made of this analysis, a few of which are briefly mentioned here before focusing on the main theme of this chapter. First, it must be noted that the MAA performed in this case does not satisfy the requirements spelled out in the government's MAA guidelines (Province of BC, 1992), as most of the accounts are only partially documented or analyzed. The analysis neglects the cost to government of administering and supporting the forest sector, and does not discuss how such costs and subsidies will be impacted by the declining timber extraction levels. The more aggressive resource extraction regime allowed by the status quo scenario is likely to result in costs to government due to environmental degradation. Government would likely have to absorb many of the costs of managing increasingly brittle forest ecosystems, of remediating landslides, and of helping municipalities to cope with deteriorating water quality. Jobs in sectors dependent on intact forest ecosystems are also likely to decline more sharply the more rapidly the forest is liquidated. None of this analysis is included. The use of average provincial values for all but stumpage revenue figures is similarly questionable, as the price fetched by timber, and wages per m^3 to employees, is generally significantly higher on the coast than in the interior.

[13] There is a multiplication error in the stumpage revenue reduction calculation provided in the MAA that overstates stumpage by a factor of 10. The MAA erroneously reports revenue loss as $10 464 000 because stumpage loss is reported at $6 539 000 rather than $653 000 (1409/1 000$m^3$ x 464 000m^3).

While these matters ought to have been addressed, the more serious problem, from the perspective of this study, is the treatment of the benefits derived from the status quo in terms which suggest that they merely involve the harnessing of an income stream to be provided indefinitely by the forest, without economic cost or consequences to government or society. The economic portion of the MAA should have noted that the status quo was not sustainable, and at a minimum should have emphasized that extraction above the Long Term Harvest Level involves one-time asset liquidation.

By ignoring the fact that the status quo base case is simply not a feasible extraction regime for more than a short period, the approach used in the MAA frames the decision such that any decline in the AAC appears economically undesirable, as it seems to involve significant job and revenue losses that could otherwise be avoided. The only reason to reduce the AAC then appears to be for expected, but optional, improvements in the environmental accounts. This inadequate way of reporting helps frame the debate in a way that denies several significant issues: the status quo involves living beyond our means, and as such cannot be considered prudent economic behaviour; the apparent benefits of aggressive extraction are ephemeral; falldown is unavoidable, yet keeps being deferred, making future transitions more traumatic; significant ecological and resource consequences are likely if extraction levels are not quickly and significantly reduced.

6.3 Application of the Ministry of Forests Methodology to the Slocan Valley Ecosystem-Based Plan

To further illustrate how the government's approach makes any resource extraction regime which maintains natural capital intact appear undesirable, this section applies the method used to evaluate the KBLUP to SFF's proposed ecosystem-based plan for the Slocan Valley. It should be noted that the SFF acknowledges that the tremendous drop in the AAC called for by the SFF would result in considerable economic hardship and job loss. For this reason, SFF proposes a transition strategy, involving government investment in ecological restoration; a value-added strategy, focused on shifting from volume-based saw-milling producing raw materials symbolized by stud lumber, to highly manufactured products such as furniture; labour-intensive harvesting and processing methods; and encouraging economic activities compatible with ecoforestry, such as wildcrafting. Furthermore, SFF stresses that much of the Slocan Valley's economy, such as tourism, home-based businesses and retirees, currently depends upon a high quality natural environment (Hammond et al., 1996: Chapter 6).[14]

Ministry of Forests vs. Silva Forest Foundation AAC

Year	MoF AAC	SFF Sustainable AAC	Difference
0	225 000	10 288	214 712
10	225 000	11 561	213 439
20	225 000	12 835	212 165
30	225 000	14 108	210 892
40	225 000	15 382	209 618
50	225 000	16 655	208 345
60	225 000	17 928	207 072
70	209 000	19 202	189 798
80	194 600	20 475	174 125
90	181 641	21 749	159 892
100	174 079	23 022	151 057

Table 6.1: Comparison between the Ministry of Forests' AAC, and SFF's ecologically sustainable AAC for the Slocan Valley over the next 100 years. The latter increases with time as a result of investment in restoration measures and as young forests age such that a sufficient proportion of the landbase is in old growth. The former declines as a result of "falldown", as a result of having to shift from living off the liquidation of old growth to living off the output of managed plantations. The Ministry of Forests' AAC exceeds SFF's AAC by over an order of magnitude, illustrating the potential size of the sustainability gap (data from Economics and Trade Branch, 1996).

As shown by Table 6.1, implementing the SFF ecosystem-based plan would involve a 96% decline in the initial AAC, while SFF's Long Run Ecologically Sustainable Yield is about 10% of the current AAC. For the purposes of this section, the reduction for the 0-9 year period is used, as this is the timeframe subjected to a Ministry of Forests analysis.

[14] An evaluation of SFF's proposed transition strategy is beyond the scope of this study.

According to the industry's methodology, the status quo is the base case against which the analyst should conduct the evaluation.

A Ministry of Forests staff review of the Silva plan projects that a 215 000 m^3 reduction in the AAC will result in the loss of 116 woodlands jobs, and a loss of 112 primary solid wood manufacturing jobs, for a total of 228 jobs directly lost. The Slocan mill would likely be rendered non-viable, in which case the total direct lost would be 296 jobs.[15]

The Provincial Impact Estimation Procedure for the British Columbia Forest Sector (Horne et al., 1996), can also be used to estimate direct, indirect and induced effects of such a reduction in timber supply. According to this procedure, each 1000 m^3 reduction in the AAC reduces direct logging jobs by 0.27 and direct sawmilling jobs by 0.34, which would translate into a loss of 131 direct jobs. Per 1000m^3 reduction in AAC, wages paid to loggers drop by $15 900, while wages paid in sawmills drop by $13 900 (Horne et al., 1996:5), for a total loss in wages under SFF's initial plan of $6.4 million. The use of this estimation procedure suggests a lower level of job and payroll loss to the local economy than do the factors used in the staff review, but for the purposes of this section the figures from the staff review are used.

Based on the average forest sector pre-tax wage per person year in the Kootenay-Boundary region of $42 100 (ARA, 1996:23), a loss of 228 person years of employment would translate into a direct wage loss of $9.6 million. According to the Arrow TSA socio-economic analysis, for every direct job in the forest sector, there are 0.72 indirect and

[15] The Ministry review is weak with respect to the mill closure The Slocan mill requires 414 000 m^3/year, while the Kalesnikoff mill requires 117 400 m^3/year (1995 figures), for a total of 531 000 m^3/year--almost double the Slocan Valley's AAC. Both mills depend on logs from outside the Valley. Thus the closure of one or both of the mills would either help to address provincial overcapacity, or would increase jobs elsewhere as another mill picks up the extra timber no longer processed in the Slocan Valley. In other words, by making the Slocan Mill non-viable, some timber originating from outside the Valley is made available to improve the viability of other mills.

induced jobs within the TSA, and a total of 1.5 direct and induced jobs in the province as a whole. This would translate into indirect and induced job losses regionally of 164, and provincially of 342. Lost wages would equal $4.4 million regionally, and $9.2 million provincially. (Provincial values here include regional values.)

To summarize, wage and employment impacts of the SFF Plan, according to government methods, would be as detailed in Table 6.2.

Wage and Employment Impacts of the SFF Plan

Direct	**Employment Loss**	**Wage Loss (millions)**
Logging	116	
Sawmilling	112	
Total Direct	228	9.6
Indirect and Induced		
Regional	164	4.4
Provincial	342	9.2
Regional Total	392	14.0
Provincial Total	570	18.8

Table 6.2: Employment and income loss due to the SFF plan when analyzed using government techniques.

Using coefficients obtained from Table 7.5 of the MAA of the KBLUP implementation strategy (ARA 1996:31), impacts on provincial revenue appear in Table 6.3.

Projected Revenue Impacts of KBLUP-IS

Provincial Taxes	**Average value per 1000m^3**	**Average revenue reduction**
Stumpage	$1 409	$317 000
Logging tax	464	199 000
Corporate income tax	1741	374 000
Sales tax	2444	525 500
Personal Income Tax*	5682	916 000
Total Annual Revenue Impact (year 0-9)		2 232 500

Table 6.3: Impacts on Provincial Revenue due to the SFF plan according to the coefficients for tax revenues used in the KBLUP MAA.

*ARA assumed that, as forest workers would be able to find alternative, lower-paying employment, the income tax loss would be 50% of that currently paid. In this analysis, because the changes are so dramatic, the income tax loss has been assumed to be 75% of that currently paid.

The above analytical approach and the figures it generates make the Silva Forest Foundation's proposal appear very undesirable. A comment contained in the Ministry of Forests' critique of the Silva plan makes clear the bias of the existing approach. According to this critique, "the difference between current harvest levels and the SFF proposal represents the timber harvesting opportunities foregone with the adoption of the SFF proposal" (Economics and Trade Branch, 1996:15). Nowhere is it admitted that status quo figures may appear good on paper only, much as Northern Cod quotas and industry revenue projections were fairly impressive until the eve of the fisheries' collapse. Nowhere is there a mechanism to take into consideration the fact that, under the SFF scenario, society would have shifted to a situation in which there was stewardship of forest capital considered broadly, and in which all the benefits could be counted as true income that would be (hopefully) indefinitely sustainable, rather than being based on unrecognized capital depletion. Nor is it easy to take into account the fact that the quality of timber extracted and the types of jobs generated would have changed, and that prospects for other sectors of the Valley economy (both formal and informal) may have improved.

6.4 Evaluating the Proposed Methodology Using Slocan Valley Data

This section explores the implications of the recommended modifications to MAA and of the recommended means of accounting for the depletion of natural capital as set out in Chapter 4. It does this by evaluating status quo policy, a moderate change scenario, and a significant change scenario, against both a strong sustainability case and against the Ministry's long run sustained yield. These comparisons provide a good illustration of the difficulty of requiring that economic analysis make adjustments to incorporate the criterion of strong sustainability. It will be restricted to this dataset, as it is more than sufficient for drawing out the key advantages and difficulties of the proposed modifications to MAA.

6.4.1 Defining and Interpreting the Strong Sustainability Baseline

If we assume for the following analysis that SFF's AAC as determined in accordance with the ecosystem-based plan is based on appropriate ecological limits, the difference between conventional practice and that consistent with strong sustainability is enormous. For instance, if timber were extracted for one year at Ministry of Forests' initial AAC, a waiting period of almost 20 years with no cutting would be required to ensure that over the 20-year period the cut remained within the ecologically sustainable AAC. Even then, there is a significant likelihood that the intensity of cut in that first year would result in ecological degradation that even a 20-year waiting period would not heal. It becomes immediately apparent that there are complications involved in defining and interpreting the strongly sustainable baseline.

Using the interest/depletion approach, the analyst needs to choose the appropriate baseline resource extraction levels held to be consistent with strong sustainability, such that extraction levels above this AAC would be viewed as depleting natural capital, and extraction levels below this AAC would be seen as appropriate use of interest provided by natural capital and potentially as investment in natural capital and future resource flows. The analyst could proceed in a number of ways to select an appropriate baseline. These methods are detailed in Appendix 2 as they are not central to the argument advanced in this study.

In the examples reported in this chapter and in Appendix 2, three approaches will be used to define the natural capital baseline. No attempt will be made in any of the examples to address how timber quality changes with different extraction regimes. The first approach will be based on Ministry of Forests' Long Run Sustained Yield as the sustainable baseline (which I believe to be ecologically unrealistic). The second approach will be based on SFF's AAC. In neither case will the natural capital baseline be recalculated for future periods to take into account ecosystem deterioration if the current cut exceeds the natural capital baseline. This simplifying assumption is made, first, because there was no model available for this study which would dynamically estimate sustainable extraction levels for future periods on the basis of current and past extraction levels. Secondly, because the MoF/SFF AAC gap is so large, if a couple of years of conventional extraction were to take place, for all intents and purposes the natural capital baseline would drop to zero. The first approach will show modest amounts of natural capital depletion for the first 90 years of cutting. The second approach involves such a wide divergence that the analysis is almost redundant. (If one accepts the SFF approach, one does not need economic analysis to illustrate that the present rate of cut is excessive.) The third approach will be to model coarsely a dynamic natural capital baseline, where the potential for future sustainable harvests declines each period in which the previous year's extraction levels were unsustainable.

6.4.2 Scenarios and Baselines Selected for Analysis

For the purposes of this scenario, an AAC of 15 000 m^3 has been selected as an ecological baseline, at or below which natural capital is to be maintained. This level is equivalent to SFF's Ecologically Sustainable AAC in year 40. The figure is selected because if it were maintained over the 100 year period, although extraction would initially be above that recommended by SFF, in later years it would be below the recommended rate, so it serves as a rough proxy for a sustainable baseline. In summary, then, the relevant extraction rates and natural capital baselines are (Table 6.4):

Slocan Valley Extraction Rates and Baselines

Scenario	**Extraction Rates (m^3/year)**	**Natural Capital Baseline (m^3/year)**	
Status quo	225 000	Conservative--LRSY	174 000
Minor compromise	185 000		
Moderate Compromise	125 000	Ecological (SFF AAC)	15 000
Significant Change	25 000		

Table 6.4 Management scenarios and natural capital baselines used in the Slocan Valley analysis.

6.4.3 Employment and Revenue Coefficients

Before proceeding with the analysis, a number of assumptions need to be made with respect to employment, income, and revenue coefficients. These are discussed in more detail in Appendix 2, as they are not central to this analysis.

6.4.4 Analysis of Status Quo, Moderate, and Significant Change Scenarios

Jobs, wages and government revenue on an annual basis for the status quo, minor compromise, moderate compromise, and significant change scenarios assessed against the natural capital baseline derived from ecosystem-based planning are shown in Appendix 2, tables A2.1 to A2.4, while totals from each scenario are compared in Table 6.5. The more conservative assessment of the status quo and minor compromise scenarios, using the Ministry's LRSY as the natural capital baseline, is shown in Table 6.6.[16] These results illustrate the obvious. As resource extraction levels decline, so too do the number of jobs, levels of income, and government revenue. Yet, the characterization of these benefits also changes from being dependent on depletion to being sustainable. The degree of change necessary, or the extent to which a scenario is deemed dependent on depletion of natural capital, obviously depends greatly on the sustainable baseline scenario.

[16] There is no point in analyzing any scenario where the proposed AAC is lower than the LRSY if the latter is selected as the natural capital baseline. If government advocated an AAC that was below the LRSY, it would probably have accepted the need to reduce the LRSY for ecological reasons. The LRSY would therefore be an inappropriate baseline for analysis.

Comparison of Extraction Regimes for the Slocan Valley
Based on a Natural Capital Baseline Derived from SFF's Ecosystem-Based Plan

Natural Capital Baseline 15000
(All $ figures in 1000s)

			Scenario AAC		
		Status Quo	Minor Compromise	Moderate Compromise	Significant Change
		225000	**185000**	**125000**	**25000**
Interest	Prop in %	0.07	0.08	0.12	0.60
	Jobs	14.6	14.6	14.6	19.1
	Wages	670.4	670.4	670.4	682.0
	Revenue	148.1	148.1	148.1	148.1
Depletion	Prop in %	0.93	0.92	0.88	0.40
	Jobs	203.7	164.9	106.7	12.8
	Wages	9,386.0	7,598.1	4,916.5	454.7
	Revenue	2,073.1	1,678.2	1,085.9	98.7
Totals					
	Jobs	218.3	179.5	121.3	31.9
	Wages	10,056.4	8,268.6	5,586.9	1,136.7
	Revenue	2,221.2	1,826.3	1,234.0	246.8

Table 6.5 Comparison of various AAC scenarios for the Slocan Valley against a Natural Capital baseline derived from an ecosystem-based plan. (Detailed breakdowns are provided in Tables 1-4 of Appendix 2).

Detailed Interest/Depletion Breakdown for the Slocan Valley
Using the MoF Long Run Sustained Yield as Natural Capital Baseline

Scenario AAC		225,000	Nat. Cap. Baseline		174,000
		Harvesting	Processing	Silviculture	Total Jobs
JOBS	(Full time equivalents)				
Coefficient(per 1000m^3)		0.38	0.44	0.15	0.97
Interest	77%	66.1	76.6	26.1	168.78
Depletion	23%	19.4	22.4	7.7	49.47
Total	100%	85.5	99.0	33.8	218.25
WAGES	($ in Thousands)				
Coefficient (per FTE)		48.00	47.00	38.50	44.70
Interest	77%	3,174	3,598	1,005	7,777
Depletion	23%	930	1,055	295	2,279
Total	100%	4,104	4,653	1,299	10,056
GOVERNMENT REVENUE			($ in thousands)		
Coefficient(per 1000m^3)			9.87		
Interest	77%		1,718		
Depletion	23%		503		
Total	100%		2,221		

Scenario AAC		185,000	Nat. Cap. Baseline		174,000
		Harvesting	Processing	Silviculture	Total Jobs
JOBS	(Full time equivalents)				
Coefficient(per 1000m^3)		0.38	0.44	0.15	0.97
Interest	94%	66.1	76.6	26.1	168.78
Depletion	6%	4.2	4.8	1.7	10.67
Total	100%	70.3	81.4	27.8	179.45
WAGES	($ in Thousands)				
Coefficient (per FTE)		48.00	47.00	38.50	44.70
Interest	94%	3,174	3,598	1,005	7,777
Depletion	6%	201	227	64	492
Total	100%	3,374	3,826	1,068	8,269
GOVERNMENT REVENUE			($ in thousands)		
Coefficient(per 1000m^3)			9.87		
Interest	94%		1,718		
Depletion	6%		109		
Total	100%		1,826		

Table 6.6 Interest/Depletion analysis of Status Quo and Minor Compromise AAC with the MoF's LRSY for the Slocan Valley as the natural capital baseline.

6.5 Application of Proposed Methodology to KBLUP-IS

To better compare the proposed methodology to an existing multiple accounts analysis, we revisit the impacts on the forest sector of the Kootenay Boundary Land Use Plan Implementation Strategy, this time using the interest/depletion approach. During the most recent Timber Supply Review, the Long Term Harvest Level (LTHL), which adjusts the LRSY to take into account adjacency requirements, was set at 3 909 000 m^3. Falldown to this level is projected to occur steadily over the next 10 decades (Fibre Targets Task Group, 1997:6). The LTHL will be used as the conservative natural capital baseline. A more strongly sustainable natural capital baseline is identified by roughly estimating that an 80% cut in the AAC would be needed, to 1 007 100 m^3/year, on the basis that SFF's ecosystem-based planning methodology is likely to lead to AAC reduction in most BC forest landscapes of between 70% to 90% (Herb Hammond, personal communication, December 8, 1996). There is only one scenario to model, the reduction of 464 000 m^3/year (or 8% of existing AAC) that is projected to result from the application of the implementation strategy. This scenario is modelled against the conservative and ecological natural capital baselines. Because the MAA does not provide specific coefficients or breakdown of wages (it omits this calculation entirely), the same factors are used as for the Slocan Valley level analysis.

Table 6.7 shows the detailed breakdown of jobs, wages and revenue, based on the situation existing before the KBLUP, assessed against a natural capital baseline set equivalent to the Ministry of Forests LTHL.

Tables 6.8 and 6.9 examine the consequences of the KBLUP-IS against natural capital baselines derived, respectively, from the LTHL and from the simulated ecosystem-based planning LRESY. Both tables show that the ultimate job, wage, and revenue losses due to the reduction in AAC implied by the KBLUP-IS are the same. Both also show that the implementation strategy takes us from a situation of higher to lower natural capital depletion. However, with the lower natural capital baseline posited by a hypothetical ecosystem-based plan, the improvement is less remarkable as there is so far to go.

Kootenay-Boundary Region Status Quo / MoF Natural Capital Baseline
(Situation **Before** Plan Implementation)

Scenario AAC:		5,499,500	Nat. Cap. Baseline: (Based on MoF LTHL)		3,909,000
		Harvesting	Processing	Silviculture	Total Jobs
JOBS (Full time equivalents)					
Coefficient(per $1000m^3$)		0.38	0.44	0.15	0.97
Interest	71%	1485.4	1720.0	586.4	3791.7
Depletion	29%	604.4	699.8	238.6	1542.8
Total	100%	2089.8	2419.8	824.9	5334.5
WAGES ($ in Thousands)					
Coefficient (per FTE)		48.00	47.00	38.50	44.70
Interest	71%	71,300	80,838	22,574	174,713
Depletion	29%	29,011	32,892	9,185	71,087
Total	100%	100,311	113,730	31,760	245,800

GOVERNMENT REVENUE ($ in Thousands)

	Coefficient($1000/$1000m^3$)	Interest 71%	Depletion 29%	Total 100%
Stumpage	1.409	5,508	2,241	7,749
Logging	0.464	1,814	738	2,552
Corporate Inc Tax	1.741	6,806	2,769	9,575
Sales Tax	2.444	9,554	3,887	13,441
Electricity Tax	0.973	3,803	1,548	5,351
Personal Income Tax	2.841	11,105	4,519	15,624
Total	9.872	38,590	15,701	54,291

Table 6.7 Analysis of the Status Quo as it existed before the implementation of the KBLUP-IS, using a natural capital baseline derived from the MoF's Long Term Harvest Level. (Note that timber processed from forests outside the boundaries of the KBLUP is not included in the analysis, because it is not contingent on the natural capital baseline from within the region.)

Kootenay-Boundary Land Use Plan / MoF Natural Capital Baseline
(Situation **After** Plan Implementation)

Scenario AAC	5,035,500	Nat. Cap. Baseline (Based on MoF LTHL)	3,909,000

		Harvesting	Processing	Silviculture	Total Jobs
JOBS (Full time equivalents)					
Coefficient(per $1000m^3$)		0.38	0.44	0.15	0.97
Interest	78%	1485.4	1720.0	586.4	3791.7
Depletion	22%	428.1	495.7	169.0	1092.7
Total	100%	1913.5	2215.6	755.3	4884.4
WAGES ($ in Thousands)					
Coefficient (per FTE)		48.00	47.00	38.50	44.70
Interest	78%	71,300	80,838	22,574	174,713
Depletion	22%	20,547	23,296	6,506	50,349
Total	100%	91,848	104,134	29,080	225,062

GOVERNMENT REVENUE ($ in Thousands)	Coefficient($1000 /$1000m^3$)	Interest 78%	Depletion 22%	Total 100%
Stumpage	1.409	5,508	1,587	7,095
Logging	0.464	1,814	523	2,336
Corporate Inc Tax	1.741	6,806	1,961	8,767
Sales Tax	2.444	9,554	2,753	12,307
Electricity Tax	0.973	3,803	1,096	4,900
Personal Income Tax	2.841	11,105	3,200	14,306
Total	9.872	38,590	11,121	49,710

Table 6.8 Analysis of the implications of the KBLUP-IS when the natural capital baseline is derived from MoF's Long Term Harvest Level. (Note that timber processed from forests outside the boundaries of the KBLUP is not included in the analysis, because it is not contingent on the natural capital baseline from within the region.)

Kootenay-Boundary Land Use Plan / Ecosystem-Based
Natural Capital Baseline
(Situation **After** Plan Implementation)

Scenario AAC: 5,035,500 Nat. Cap. Baseline: 1,007,100
(Based on ecosystem-based aac)

		Harvesting	Processing	Silviculture	Total Jobs
JOBS (Full time equivalents)					
Coefficient(per $1000m^3$)		0.38	0.44	0.15	0.97
Interest	20%	382.7	443.1	151.1	976.9
Depletion	80%	1530.8	1772.5	604.3	3907.5
Total	100%	1913.5	2215.6	755.3	4884.4
WAGES ($ in Thousands)					
Coefficient (per FTE)		48.00	47.00	38.50	44.70
Interest	20%	18,370	20,827	5,816	45,012
Depletion	80%	73,478	83,307	23,264	180,049
Total	100%	91,848	104,134	29,080	225,062

GOVERNMENT REVENUE ($ in 1000s)	Coefficient($1000 /$1000m^3$)	Interest 20%	Depletion 80%	Total 100%
Stumpage	1.409	1,419	5,676	7,095
Logging	0.464	467	1,869	2,336
Corporate Inc Tax	1.741	1,753	7,013	8,767
Sales Tax	2.444	2,461	9,845	12,307
Electricity Tax	0.973	980	3,920	4,900
Personal Income Tax	2.841	2,861	11,445	14,306
Total	9.872	9,942	39,768	49,710

Table 6.9. Analysis of the KBLUP-IS in place with a natural capital baseline derived from a hypothetical ecosystem-based plan, whereby the AAC would be much lower than MoF's Long Term Harvest Level. (Note that timber processed from forests outside the boundaries of the KBLUP is not included in the analysis, because it is not contingent on the natural capital baseline from within the region.)

CONSEQUENCES OF THE KBLUP
Comparison Between the Status Quo and the KBLUP
(Analyzed with the MoF LTHL as the Natural Capital Baseline)

Natural Capital Baseline (All $ figures in 1000s)			3,909,000	(MOF LTHL)
SCENARIO:		Status Quo	KBLUP-IS	Difference
	AAC	5,499,500	5,035,500	464,000
Interest	Prop in %	0.71	0.78	0.07
	Jobs	3,792	3,792	0
	Wages	169,471	169,471	0
	Revenue	23,063	23,063	0
Depletion	Prop in %	0.29	0.22	0.07
	Jobs	1,543	1,093	450
	Wages	68,955	48,838	20,116
	Revenue	9,384	6,646	2,738
Totals				
	Jobs	5,335	4,884	450
	Wages	238,426	218,310	20,116
	Revenue	32,447	29,709	2,738

Table 6.10 Net effect of the KBLUP-IS when analyzed using the MoF's Long Term Harvest Level as the natural capital baseline. While the analysis predictably shows that jobs, income and revenue drop, it also makes clear that society is becoming less dependent on natural capital depletion as a result of implementing the land use plan.

6.6 A Transition Scenario with Dynamic Ecosystem Model

A subject of great interest amongst ecoforesters, ecological economists and those advocating sustainable development is the difficult transition period, from clearly unsustainable, material-intensive, and natural capital degrading industrial economies, toward sustainable economies that provide for high levels of social well-being. A transition scenario is analyzed for the Slocan Valley in Table 6.11. At the same time, this table illustrates analysis carried out with a dynamic ecosystem model, where the natural capital baseline drops in response to excessive extraction in earlier periods. One sees that rapid

Rapid Transition with Dynamic Natural Capital Baseline and Large Initial Sustainability Gap

(All $ figures in 1000s)

		0	1	2	3	4	5	6	7	8	9	10	Totals
	Year:	0	1	2	3	4	5	6	7	8	9	10	
Reduction in Baseline (m^3):		0	1476	1183	950	764	617	499	405	330	270	223	
Natural Capital Baseline (m^3):		30000	28524	27341	26392	25627	25011	24512	24107	23776	23506	23284	
AAC (m^3)		100000	76667	60619	49527	41815	36419	32616	29915	27979	26578	25554	
Interest	Prop in %	0.30	0.37	0.45	0.53	0.61	0.69	0.75	0.81	0.85	0.88	0.91	
	Jobs	29.1	27.7	26.5	25.6	24.9	24.3	23.8	23.4	23.1	22.8	22.6	274
	Wages	1,300.6	1,236.6	1,185.4	1,144.2	1,111.1	1,084.3	1,062.7	1,045.1	1,030.8	1,019.1	1,009.4	12,229
	Revenue	296.2	281.6	269.9	260.5	253.0	246.9	242.0	238.0	234.7	232.1	229.9	2,785
Depletion	Prop in %	0.70	0.63	0.55	0.47	0.39	0.31	0.25	0.19	0.15	0.12	0.09	
	Jobs	67.9	46.7	32.3	22.4	15.7	11.1	7.9	5.6	4.1	3.0	2.2	219
	Wages	3,034.8	2,087.2	1,442.7	1,003.0	701.8	494.6	351.4	251.8	182.2	133.2	98.4	9,781
	Revenue	691.0	475.3	328.5	228.4	159.8	112.6	80.0	57.3	41.5	30.3	22.4	2,227
Totals													
	Jobs	97.0	74.4	58.8	48.0	40.6	35.3	31.6	29.0	27.1	25.8	24.8	492
	Wages	4,335.4	3,323.8	2,628.1	2,147.2	1,812.8	1,578.9	1,414.1	1,296.9	1,213.0	1,152.3	1,107.9	22,010
	Revenue	987.2	756.9	598.4	488.9	412.8	359.5	322.0	295.3	276.2	262.4	252.3	5,012

Table 6.11 Analysis of a rapid transition scenario with simulated dynamic natural capital baseline. The natural capital baseline initially specified is fairly ecologically cautious (being 30% of the AAC under status quo management). In each year, AAC reductions are specified in this model so as to close the natural capital baseline - AAC gap within three years, but because the natural capital baseline keeps declining as a result of over-exploitation in previous years, the gap does not disappear. (Jobs, wages, and revenue per 1000 m^3 are not adjusted to take into account how these coefficients are expected to change with the transition to ecoforestry from industrial forestry.)

adjustment towards strong sustainability quickly reduces total benefits, but also improves the interest/depletion ratio, and thereby prospects for long term sustainability.

6.7 Review: Does the Proposed Methodology Meet the Criteria for Useful Economic Analysis?

In Chapter 5, various criteria were proposed to assess proposed methodologies for integrating the requirement to account for natural capital depletion. The proposed interest/depletion methodology is reviewed against these criteria in the subsections that follow.

The above examples of how the interest/depletion approach could be applied only show a small part of the overall package, and have focused only on the stream of benefits derived from timber extraction. An analysis which undertakes to follow all the other requirements for the proposed MAA methodology has not been carried out, as it is beyond the resource constraints of the present study. In the assessment that follows, it is assumed that the methodology to account for the depletion of natural capital would be applied as part of a multiple accounts analysis of different resource extraction regimes that incorporates the recommended changes to the multiple accounts as specified in Chapter 5.

6.7.1 Ease of Use

If the analyst has some proxy for a resource extraction regime that is consistent with maintaining natural capital, it is relatively straightforward to divide benefits derived from resource extraction into interest and depletion accounts. It is therefore a tool which can easily be put to use, so long as ecological limits or constraints have been identified or modelled.

This latter condition is the most onerous. Ecosystem-based planning is rarely performed. It is likely that the analyst will need to devise a proxy for an ecological baseline. One obvious initial proxy is to use the LRSY, because it is difficult, even from a status quo perspective, to argue against the proposition that cutting above this rate involves the depletion of natural capital. However, as shown in Chapter 3, the LRSY based on conventional practices is likely to result in systematic ecological degradation, so decisions made on the basis of such an analysis, while likely to lead to an improvement from the status quo, would likely lead to unpleasant surprises in the future. A second option would be to use estimates by new forestry advocates, to appoint scientific panels such as that established for Clayoquot, or to scale and adjust results obtained from an ecosystem-based plan for a region similar to the area in question.

The object is not to hold off all analysis until precise numbers can be generated, as precision in such matters is impossible. Rather, the intent is to put forth a sustainability guidepost, to be continually revisited. Beyond this guidepost, extraction is seen as depletion. The guidepost is similar to Daly's Plimsoll line analogy: while a cargo ship loaded beyond the Plimsoll line may safely make an ocean voyage, the crew knows that chances are being taken (Daly 1992:190). There may be some latitude in extraction levels and perhaps a function could be devised wherein extraction rates within, say, 25% of the baseline are only partially considered to involve depletion. This baseline should be subject to reassessment as better ecological knowledge becomes available, as the implications of past cutting rates are seen, and as new methods of landscape ecology analysis and ecosystem-based planning become available. When the sustainable baseline is being initially set, the precautionary principle would require that it be set lower rather than higher, thereby keeping options open and avoiding irreversibilities (O'Riordan and Cameron, 1994:16-18).

6.7.2 Consistency with Economic Theory

The approach advocated here is deceptively simple, once the ecological baseline is known. It is easy to explain, by drawing on the concept of income. It does not rely on difficult techniques of valuation or aggregation, nor does it require some of the more complicated techniques advocated by El Serafy or others as reviewed in Chapter 4. It does require attention to strong sustainability.

6.7.3 Open to Elaboration

The interest/depletion approach is open to more sophisticated elaboration, on both economic and ecological sides. With respect to the former, it would be possible to undertake a fuller risk analysis, and define a function to more accurately capture the likely shift from income to depletion as extraction nears the natural capital baseline, as it is unlikely to be a strict boundary. When extraction drops below the baseline, the economist and ecologist need to decide how this deferred extraction should be shown as investment in natural capital. The analyst can decide whether or how to discount future streams of benefits, yet discounting does not play a role in how the ecological baseline itself is set, or how it ends up dividing the stream of benefits. With respect to the ecological side, the ecological baseline could be based upon sophisticated ecological modelling or upon rough but reasonable estimates. Either way, the analyst should document the methods used to define the baseline, and note the uncertainties implied by relying upon ecological modelling and predictions.

Perhaps the most significant theoretical improvement, in comparison with existing practice, is that the economic and ecological accounts no longer exist in separate realms, where the economic accounts can go on showing benefits that take no account for ecological deterioration. Rather, the two are combined, and those making the decision are confronted with the linkage between ecosystems and economies.

While many different means of showing such a linkage have been advanced in the past, some have failed because they require a paradigm shift. No such shift is necessary here. The concept of income is as old as the profession of economics itself, and it does not require a new conceptualization for either the analyst or the public.

6.7.4 Focus of Debate

By use of an admittedly simplistic procedure, this revised method of analysis gives legitimacy to important questions in the forest land use debate. It forces the question, "at what point are we eating into natural capital?" There is of course nothing to stop the economic analyst from adopting, or from being given, a natural capital baseline which would clearly be an unsustainable resource extraction regime. On this matter, two points need to be made. For the first time, the economist carrying out such analysis in BC would be forced to take into consideration an ecological reference point. Before, the economist could ignore the question altogether. Secondly, the methodology allows peer and public debate on the appropriate baseline beyond which natural capital is held to be depleted. It does not deny that extracting resources at rates that are unsustainable generates benefits, but it changes the label attached to such benefits. Jobs are then based either on interest or on depletion. Those that are based on depletion can be seen as benefits appropriated from the future, or, if extraction rates are sufficiently high, as jobs which foreclose upon the future.

This allows for a second shift. By moving from "status quo" as baseline, to an ecological baseline, the focus shifts from avoiding job, income and revenue loss as tradeoffs against which to weigh sustainability, to increasing the proportion of jobs, income or revenue that are sustainable, and to moving to an economy that generates greater benefits on lower throughput. This is not to deny that lower rates of extraction entailing decreased economic flows will result in hardships and dislocation. It is to recognize that these changes can either be planned for or imposed by nature (Daly, 1992b:126).

The examples explored in this chapter also illustrate one of the key weaknesses of this methodology. When there is a wide divergence between current practice and that thought to be sustainable, the results appear to be absurd or too overwhelming to accept. What is one to make of an analysis which suggests that up to 96% of current logging jobs are unsustainable? The changes required are beyond comprehension. However, this does not impugn the validity of the technique. As Nyborg has noted, correcting for natural capital depletion,

> ...will in some cases lead to seemingly unreasonable results. On closer scrutiny, the results may not be so unreasonable after all: for instance, if one wants to determine how much of current economic activity could have prevailed if environmental standards were not allowed to deteriorate during the accounting period, and the answer to this turns out to be zero, this may well be the correct answer. And if so, we should really be concerned about how to improve modern economy's ability to cooperate with nature, rather than hiding this result behind flexible evaluation procedures that allows us to make more "reasonable" corrections (Nyborg, 1993:346).

6.7.5 Public Acceptance

In discussions with community members, environmental activists and forestry professionals during the groundwork on the Slocan Valley case study, the interest/depletion approach has proven easy to explain and has so far met with positive reactions. It is grounded in everyday concepts. At the same time, there are many people involved in efforts to change the cutting regime in the Slocan Valley who feel, or would feel, I am sure, were the subject broached, that such a change in the way economic analysis is undertaken will at best make a marginal contribution to change, but will more likely result in no change at all. If government and industry have not been willing to change despite years of meetings, culminating in protests, jail terms and civil damage suits, they are unlikely to change as a result of an economic analysis whose ecological baseline is open to debate, and which shows that most jobs, income and revenue are unsustainable. In this respect, the proposals advanced here at least move economic analysis from being the indispensable servant of the status quo (Heilbroner and Milberg, 1995:127), to becoming an instrument favouring at least incremental, if not fundamental, changes.

6.7.6 Encourage More Sustainable Economic Activity

The interest/depletion approach provides signals which encourage more sustainable behaviour, so long as the natural capital baseline is appropriately defined. The dependence of the economy on ecosystem health is made explicit. It makes clear that once all benefits are based on income, they can be enjoyed for the long term, while extraction beyond this rate involves future consequences, difficult to predict. The most obvious consequence is that the sustainable baseline declines as excessive extraction continues, and an ever decreasing stream of benefits can be safely relied upon. It shows that deferred consumption increases the value of the stock of natural capital, but not by engaging in difficult valuation exercises aimed at assigning a change in the value of the stock of natural capital. Rather, the intent is to allow the ecological side to show how the flow of benefits will increase.

6.7.7 Tradeoffs between Various Uses of Natural Capital

This research project has focused on the forest and its ability to generate a flow of timber, and the forest as provider of ecological services. It has not focussed on how timber extraction could be compared to other forest uses, although it can and should be applied for such a purpose. To do this, sustainable baselines for other uses need to be estimated, and so this criterion can be met. It does illustrate the tradeoffs involved between different rates of timber extraction, by relating the extraction levels to both benefits and the extent to which benefits are sustainable.

6.7.8 Fitness with Respect to Ecological Limits

The proposed approach gives a rough proxy for the fitness of the economy with respect to ecological limits, if of course the sustainable baseline is appropriately selected. For instance, if jobs in regions A and B (both timber-dependent economies) are respectively 75% and 40% dependent on depletion, it is obvious that region B has better prospects for making the transition to a sustainable economy. Economy A would be more vulnerable to approaching ecological limits.

6.7.9 Proper Contribution to Decision-Making

Early advocates of Cost-Benefit Analysis often advanced the case, explicitly or implicitly, that well-performed CBA would help determine the appropriate course of action, reducing the need for messy public debates (see Hausman and McPherson 1996 for a discussion of this tendency). In this research project, the perspective taken is that well-performed analysis brings forth the important issues for public debate, rather than burying them in assumptions, and that those making the decision should be given the opportunity to query the inputs and assumptions and weigh the results of the analysis in an open forum. The goal is to conduct analysis which encourages a full vetting of the relevant issues.

6.7.10 Overall Assessment

This review has shown that the modifications proposed to take into account the maintenance of natural capital in economic analysis are generally easy to apply once natural capital baselines are defined, consistent with accepted mainstream theory, and useful. However, they are of limited usefulness. The methodology is easy to abuse, if the natural capital baseline is defined too high or inappropriately. Or, if the baseline is defined too high out of ignorance, rather than to excuse the status quo, it could mislead or result in complacency. Furthermore, there is no guarantee that conscientious use of this methodology would affect decisions taken. The forest sector in BC has shown itself remarkably resistant to significant change, despite public opinion and an extended scientific and layperson's critique of status quo practices.

In the end, the approach advanced in this research study is not a panacea. What is clear, however, is that if economic analysis of forest use options continues as per current practice, without taking into account the depletion of natural capital, such analysis will help to justify courses of action that will likely have highly undesirable and inescapable consequences for the future. It would not reflect honest reporting. Passing laws prohibiting drivers from drinking does not guarantee that accidents involving alcohol won't happen. Similarly, requiring that natural capital depletion be taken into account by those undertaking economic analysis on behalf of society does not offer any guarantee that forest extraction regimes will be sustainable. Yet neither drunk driving, nor continuing to perform economic analysis that neglects the ecosystems on which the economy depends, can be tolerated by a society intent on the greater good or interested in the long term.

Chapter 7: Economic Analysis in Context: Slocan Valley, Summer 1997

7.1 Preparations

I return to Nelson in late June 1997, and take advantage of the offer of a cheap office at the Ecocentre in downtown Nelson. For the next few months, I am immersed, whether or not I wish to be, in the trials and tribulations of the more radical and disenfranchised part of Nelson's environmental community.

In the early summer, the Valhalla Wilderness Society is in and out of court trying to overturn logging road building permits, to no avail. As it becomes clear that all officially sanctioned means to challenge road building plans have been exhausted, a number of activists focus on setting up a Peace Camp in the Slocan Valley, a base from which to plan and execute civil disobedience. Calls go out from the Peace Camp for shovels, axes, tarps, tents, organic food, and volunteers to help build everything from privies to a kitchen. The day before road construction is to begin, I spend a rainy day helping to cut firewood, preparing a clearing for meetings, and building a security/information booth out of discarded slabs obtained from a local sawmill. All of us are made to understand the Peace Camp's code of ethics, requiring sober and non-violent behaviour.

We are up early the next morning. Appetites are slight due to nervous anticipation, and much of the morning fare prepared by the breakfast crew remains untouched. The forty-odd of us who stayed overnight at the Peace Camp are joined by an impressive crowd of locals as well as people who have driven in from Nelson. Car-pooling is arranged, and our convoy heads up to a side road where the Perry's Ridge road is to be pushed through the woods.

It takes some time for us all to take up position between the rows of flagging tape demarcating the road, to put banners and placards in position, and to hear the instructions from the Perry's Ridge Water User's Association, hosts of this blockade. We are a diverse crowd: a Quebecoise who has just finished a stint as a volunteer on a Slocan organic farm; teachers; an architect; small business owners; neo-hippies and new age travelers; adherents of voluntary simplicity; professionals; farmers; retirees; and many others. There are Valley residents, Nelsonites, supporters whose watersheds are threatened in other valleys, as well as urban and international contingents. If the logging road will indeed affect domestic water supplies, then it is appropriate that I stand here in the crowd assembled, as for a number of months I myself depended upon the water from McFayden Creek, one of the many small creeks that tumble down from Perry's Ridge.

A handful of police officers arrive, so we take our position more formally, and raise our placards. But the RCMP make no move, other than to explain that they are merely here to maintain the peace--until, at a later date, they are compelled by a court enforcement order to arrest us. After a time, Bob Barkley of the Slocan Valley Equal Access to Public Resources (SVEAPRS) share group shows up to address us. Retorts from the crowd and logging trucks passing along the gravel road from unrelated cutblocks further up the side road keep disrupting Barkley's speech, but he puts the trucks to good use as props in his speech. Each time he sees a loaded logging truck, Barkley explains, it is so many thousands of dollars of revenue flowing into the province's coffers: five or six truckloads and his wages as a school bus driver are paid for the year. It's a fact we cannot deny, it's the lifeblood of the provincial economy, so why do we try to disrupt the industry on which we all depend?

A representative from the Castlegar office of the Ministry of Forests arrives. We are requested to leave the road, and invited instead to meet with Ministry representatives in Castlegar for reasoned discussions. Knowing the long history of community attendance at meetings, the countless written submissions, and the like, such an offer appears absurd. Making offers of reasoned dialogue, thereby casting the protest as unnecessary and disruptive, seems to make sense only as a means for the Ministry to position itself effectively in the media battle ahead. Despite such entreaties, no one moves from the road. The Ministry of Forests representative tells us the next step: the government will go to court to get an injunction, then if necessary an enforcement order, at which point anyone who interferes with road construction will be arrested. We are soon left on our own. After sorting out who can be at the blockade for the next few days, and sharing whatever food people have brought along, people slowly drift off.

Day after day, a small group blockades the Perry's Ridge road. The government stalls on pursuing an injunction. Soon it is clear that New Denver Flats, site of a similar protest, will be the first place where an injunction will be served.

7.2 Arrests

7:00 a.m. July 22, 1997, New Denver, BC

A formidable RCMP presence has transformed the sleepy town of New Denver. The rich mineral veins that gave birth to the former mining town are now exhausted. During the Second World War, New Denver served as an internment camp for Canadians of Japanese descent, an earlier exercise of state power that decades later is a source of shame. The town now taps into tourists and retirees for its lifeblood. This morning, though, New Denver has become one more of the battlegrounds in the "War of the Woods." Over three hundred protesters stand peacefully early this summer morning, blocking road building equipment from New Denver Flats, a watershed with small remnants of now rare old growth. The protesters are hemmed in by two lines of pylons and plastic ribbons--POLICE LINE--DO NOT CROSS--and they are on the wrong side of the line.

As an RCMP officer reads out the injunction, each protester faces a tough decision. To stand firm is to be in contempt of court, a charge which can be civil or criminal. If the latter, it is the only criminal charge outside of the Criminal Code of Canada. It means any of up to 30 days in jail, a fine, probation, and a criminal record, a blemish that could affect future job prospects. Being arrested exposes one to the potential liability for costs in any ensuing law suit that might be launched by loggers for lost wages, or by Slocan Forest Products for conspiring to harm its economic interests. To cross the line is to get out of the way of the industrial machinery, to allow the ancient grove behind us to be reduced to stumps for about nine days of work at the local mill in Slocan. It is to leave Slocan Forest Products and Ministry of Forests plans unchallenged, it is to allow the first of over 139 clearcuts scheduled over the next five years in the Slocan Valley. It is, for many, to do what feels morally wrong and what intellectually makes no sense. It is but the first of six watersheds to be logged this summer, over the vociferous protest of those dependent on forests of these steep mountainsides, and on these pure mountain streams, where one can drink freely--for the moment--without fear of water-borne illness or silt.

The RCMP officer finishes reading the injunction. This is the critical moment for this diverse crowd of mothers with children at their breasts, of farmers, of small business owners, of those who have dropped out of the mainstream, of activists, and of a lone employee from the mill whose wood supply we impede. A SWAT team awaits, prepared for a mass arrest or worse. Not one detail has been overlooked: stretchers, paddy wagons, and tear gas are at the ready. Ministry of Forests staff, apparently quite shaken up by the first mass arrest in the Slocan Valley at Hasty Creek in 1991, now seem to be accustomed to their part in what a casual observer would be forgiven for interpreting as a ritual. Everyone, whether protester, Slocan Forest Products or Ministry of Forests employee, logging crew member, or RCMP officer, everyone knows his or her part; each act flows without a hitch.

We each make our decision. The crowd seems surprised; the RCMP relieved: fewer than a dozen people are left standing their ground. The arrests are over in less than ten minutes. There are cheers as each arrestee is escorted off, but the cheers do not come from our solemn crowd now standing on the legal side of the ribbon. Of the seven arrestees, three have Ph.D.s. One, Dr. Stan Rowe, is one of Canada's most respected forest ecologists, a 19-year veteran of the Canadian Forestry Service, and a professor emeritus of the University of Saskatchewan. Another, Eloise Charet, who once saved 63 orphans during the war in Cambodia, is arrested with her 12 year-old daughter.

The cheers come from a crowd of IWA members and supporters gathered on the other side of the rural highway that runs the length of this valley. Loggers and protesters are kept separate by the RCMP. Rumors spread that the mill gave its workers time off work to counterprotest, but these rumors are later denied. For the loggers, truckers and mill workers, the issues are also clear. Their work depends on logging, and this interference in industry's normally unquestioned access to timber has heightened fears for the future. "Logging means jobs, jobs mean taxes, taxes pay welfare--WAKE UP!" exclaims one placard. All the placards look to be fresh out of a sign shop. They gather under the leadership of SVEAPRS--Slocan Valley Equal Access to Public Resources, the local chapter in the highly sophisticated and industry initiated "share" campaign.

Once the last human impediment to progress is handcuffed, a flatbed carting a bulldozer arrives. The loggers and their supporters cheer as the bulldozer awkwardly clambers to the ground. Every eight feet along both sides of the road, RCMP officers are positioned to hold back us protesters, as if the bulldozer's passenger was an important dignitary. As the cat rumbles past us to the sweet woods ahead, faces in the crowd contort. Each of us struggles to keep back tears, anger and frustration. A few of us fight the temptation to make the apparently futile jump to the other side of the ribbon, to give an ancient grove but a few more moments of life, to keep an extra few gallons of water clear. There is a feeling of incredulity. Many in this crowd have been working a decade, even two, to protect their watersheds. The people of this valley have written letters, signed petitions, sent delegations to Victoria, proposed alternatives, commissioned studies, sat at land use planning tables, but now all options have been exhausted and the chainsaws have arrived. Reality hits: this area, like so many others, will be defaced by industrial access roads and clearcuts. One more grove whose ecological richness will only show up as obscure codes on forest inventory maps. Rather than drawing locals and travelers alike to wonder at its richness, rather than allowing for small scale timber extraction spread over many decades, in the future this site will mainly attract silvicultural field crews. They will come to check on restocking, to prescribe treatments to ensure that this site, once replanted, does its fair share, now that it has been brought into the fold of the working forest. The forest become tree farm will, for many generations, fail to provide the same clear waters and the diversity and richness of life. It is hard to see how the New Denver flats could ever command again the loyalty of as many people as it holds this morning.

I am in this crowd as part of my quest for a master's degree. As the bulldozer nears, the intellectual arguments that I seek to address in my thesis appear entirely irrelevant. In my mind I see an image from Tianneman Square, a lone student refusing to move and so immobilizing a line of tanks. I want to jump the line. The camera crews are there to record the moment--will the drama of the clip in the evening news make enough of a difference to make it worthwhile? The moment passes, I betray the woods. We watch helplessly as the machine disappears into the woods. A few speeches, efforts to comfort each other, and the crowd slowly disperses.

7.3 Reaching Out

Clad in outlandish costumes, faces hidden by paper mâché masks depicting various animals and spirits, a group of almost 30 street performers head down Nelson's main street. With drums beating, and a number of breasts exposed to the summer sun, these actors dramatize the Valley's plight. I do not participate: my middle class roots reveal themselves, infusing me with feelings of discomfort and alienation. The light turns green, red, and green again, and still the burly man at the wheel of a 4 by 4 stares determinedly ahead, unmoved, or perhaps pissed off, by the colourful act blocking the intersection.

There are other efforts to spread the message: newsletters, petitions, advertisements in the newspaper, phone-in campaigns, slide shows and fundraisers, and almost daily news releases from the Valhalla Society or local watershed groups. The story rarely garners provincial, let alone national, coverage.

As one segment of society becomes more committed to change, and lives out that commitment, it distances itself further from the very mainstream whose support it will need. The lines of division widen to a chasm, and as passage across the divide becomes ever more difficult, even the simplest message often can't make it across. The problem is compounded when one side tries to speak through poetry, art, and metaphor, often with a disdain for facts, while the other sides focuses on a narrow rationality bounded by the need to be pragmatic and realistic.

7.4 Court

The number of arrests mounts over the course of the summer, and keeping track of all the upcoming court dates is next to impossible. I seldom attend. As the defendants are charged with contempt of court, they have no opportunity to present evidence regarding their concerns about proposed logging. Still, despite mounting frustration against a court system which many come to believe only protects the status quo, the arrested speak eloquently through statements deposited during their trials. Forest ecologist Dr. Stan Rowe's statement is worth quoting at length:

> No one who values the rule of law breaks the law lightly. ...It is a conscientious act, a democratic last resort after all else has failed...
>
> ...The pleas of Village Councils and citizens' groups to bar logging from critical watersheds have been ignored. Rural communities are desperately trying to protect the land-and-water ecosystems within which they live, and on which they depend in many ways, not least for the quality of life that also attracts city people on their holidays.
>
> Those who live in valleys like the Slocan want to look around them and see real forests, not blocks of even-aged plantations. They want to turn on the tap and drink pure water, not the chlorinated or bottled kind. They want to preserve the few remaining fragments of old unlogged forests, along with their marvelous plants and animals. ...They are not against felling trees for worthy purposes but they want it done in designated areas with patient care. They abhor the cheap and careless patch-shaving of mountainsides that masquerades as "forestry." They want a community share in planning their region's future, not smoke-screen sessions inviting public input after the big decisions have been made.
>
> In short, people in the hinterland want to protect the productivity of their regions, and the only path to that goal is first to protect the beauty, health and permanency of the forest-and-water ecosystems there. This necessitates far-sighted, long-term land-use planning. The Silva Forest Foundation has provided a basis for such ecological planning in the Valley. ...
>
> At the moment, unjust laws and regulations stand in the way of reasonable land-use planning solutions. Short-sighted, short-term goals have been set for short-term jobs and short-term profits. As machines replace people in the forest and the mill, governments desperately try to take up the slack by creating temporary jobs. ...

> Those of us who stand on roads to slow down the machinery do so to make time for solutions to the widespread unrest wracking the Valley. Creative initiatives are needed now, if the province is to have a sustained future...

The urgent need for change and despair at the momentum of the status quo appear in the statements of most arrestees. For instance, Matt Lowe, who took the more serious step of locking himself to roadbuilding equipment, explained in his statement,

> I obstructed roadbuilding at Perry Ridge because of my conviction that we must stop our destructive practices on the earth, like the government/industry planned logging for the Slocan Valley, or run out of time to change...

Richard Allin, a director of the Slocan Valley Watershed Alliance, described the futility of involvement in government sanctioned processes and the poor returns on two decades of work towards watershed protection and alternatives to industrial forestry:

> For nearly two decades, many of us in the Slocan Valley have been learning about and working for ecologically responsible forest management that includes all interests in the community. I personally have attended hundreds of meetings to pursue these aims as a director of the Slocan Valley Watershed Alliance and as a water-user representative at various government-organized planning tables.
>
> There is some hope on the horizon, but we currently risk losing what we are trying to protect while the wheels of industry churn ever faster and the wheels of change grind slowly on.
>
> I was feeling a large measure of frustration and the weight of years of seemingly fruitless effort when I stood on the road at Perry's Ridge with hundreds of others in support of the water users there.

Another theme frequently heard is that corporate influence on government is so powerful as to preclude most initiatives aimed at sustainability. As Kenneth Lowry's statement sets out,

> Here in the Kootenays, citizens are aware of the pending crisis and are offering alternative models that maintain jobs and environmental integrity, but we can get no serious consideration from our big business-minded government. We see that as we give up our forest to the corporate world, we give up the potential for a truly sustainable value-added industry as well as ecological integrity, biodiversity, and sustainable clean watersheds.

In a letter to Premier Clark, written while still jailed for refusing to sign an undertaking not to return to the blockades, Eloise Charet describes a history of natural capital depletion:

> I live in the most beautiful valley but around me lay bare the scars of our history. Hard working miners who risked their health to feed their families as they watched most of their ore and profits go to the USA. Then came the damn dams, many forced on people against their will. They lost the most precious commodity in the mountains, rare fertile earth and spawning grounds... (Charet, 1997).

These statements have no apparent effect in the court room or in the political arena. There is shock at Andrea and Matt's sentences of 14 and 28 days in jail, respectively, plus 24 months probation. For a few days, they are kept in the Nelson jail, and I drop by each morning with letters or postcards. One morning, the officer on duty quips, "More letters, more paper, more trees logged." I feel frustration at how the issues are trivialized.

While Matt is still in jail, and while charges pend against others, Ike Barber, Chief Executive Officer of Slocan Forest Products, is named Pacific Canada's Entrepreneur of the Year. He is cited as a role model for aspiring entrepreneurs and proof that risk taking and hard work pay off. On November 13, the day that Matt is released, Justice Parrett overturns the Perry Ridge injunction that allowed Matt to be cited for contempt of court in the first place. Justice Parrett chastises the forest service for failing to properly provide him with all relevant information at the first hearing when the injunction was granted, leaving him with a faulty impression about the effects of road construction and logging on Perry's Ridge:

> The impression can be fairly characterized, in my view, in this way: the Arrow Forest District is in critical need of timber, we have been studying this matter since 1978, we have sought public input and postponed logging while we consulted the public and extensively studied the matter [and] now we are ready to proceed and these groups won't co-operate. The impression was also created that these opponents were concerned with "water quality" issues and that any concerns in that regard had been attended to by the "numerous hydrological slope stability and engineering assessments" all of which had been "undertaken to ensure that both road construction

> and future timber harvesting within Perry Ridge are as environmentally sensitive as possible." ...
>
> This impression hardly does justice to the concerns of Austin Greengrass. ... On October 4, 1996, Mr. Greengrass' property and home had an assessed value of $104 000; by the end of that day or the next it had an assessed value of $6 900. ...
>
> Mr. Greengrass in his affidavits speaks eloquently of his concerns for the effect road construction and logging on Perry Ridge will have on the many people living below the ridge, both as to the quality and quantity of their water supply, and the stability and safety of their property. ...
>
> There is found within [the] expert reports a disturbing consistency. Each raises significant concerns and each, directly or by implication, calls for or recommends more detailed study. It is not my task on the present application to reach general or specific conclusions as to the implications of these various reports. I have taken the time I have to set out these passages because in my view, these reports, coupled with the incidents of landslides detailed by the various affidavits, represent a significant area of concern which was almost entirely absent from the court application in July (Attorney General for BC v. Perry Ridge Water Users Association et al., 1997).

Shortly after the injunction is overturned, the Attorney General's office launches an appeal,[17] while the Ministry of Forests insists that road building is to continue on schedule. Justice Parrett's decision appears to be best characterized as a judge's displeasure at the court's being used by being given only part of the story, rather than as a decision intended to force the Ministry to protect the integrity of forest ecosystems. Despite this small victory, rules for resource extraction remain unchallenged.

7.5 Life in the Kootenays

On Wednesday evenings, I play volleyball. I am one of the few players who is not a Ministry of Forests employee. We have casual conversations while rotating on or off the bench. I rarely bring up my work, nor do I hear much of theirs--nor mention of the

[17] This appeal was unsuccessful. Nevertheless, other defendants were subsequently convicted despite the fact that the injunction they had disobeyed was thus invalid.

struggle which so divides communities. Every second Friday, the "Dead Ecologists' Society" meets, and participants present recent ecological research and discuss its implications. The membership is mostly made up of employees of the Ministries of Forestry and of the Environment, as well as local environmental consultancies. From the vigorous discussions which occur on these occasions, it is apparent that there is a base within government for at least incremental change toward a more ecological style of forestry.

There are potlucks, invitations to coffee, hikes, back country ski trips. Colleagues in environmental and resource management fields report that finding a steady, interesting job is not always easy in the Kootenays. Some friends complain of having little option but to do field work which supports industrial forestry, such as vegetation surveys and silvicultural prescriptions for cutblocks. Yet, all in all, life here for my peer group is relatively good. The coming shocks, both economic and ecological, which so many of the local environmentalists anticipate imminently as limits are reached, seem unreal. And yet, in conversations with tree planters and biologists, certain themes keep coming up. "The wood isn't out there," or, "that area has been trashed." Personal testimony adds to the sense that liquidation forestry is still the order of the day.

Reports of poor logging practices and of their consequences are frequently heard in the Ecocentre. Rarely does a week go by in which a forestry issue does not hit the front page of the *Nelson Daily News* ; "Study shows shrinking forest," (February 3, 1997); "Marchers protest logging plans," (February 26, 1997); "Protests erupt in Slocan Valley," (July 15, 1997); "Police ordered to arrest protesters," (July 21, 1997); "Jailed protester starts hunger strike," (July 24, 1997). And this is not a recent phenomenon. Going through earlier papers, similar headlines appear with striking regularity: "No second chance for Lasca Creek," (July 24, 1991); "Lasca Creek protest turns ugly," (July 25, 1991), "64 protesters arrested at Lasca Creek," (September 25, 1991), "Save water, save view say protesters," (June 20, 1994).

In the subset of this community with which I am surrounded, longtime participants in the push for a more ecological approach despair of change. "Most of what I work for I do not because I believe we'll change, I just do the work to keep my sanity," says a longtime activist who also works out of the Ecocentre. Those whose livelihood depends on the status quo have their own reasons to despair. Knowing that the AAC must come down, every additional area removed from the productive landbase, and every tightening of logging standards, is seen as a threat to jobs and to a standard of living. Too much has been preserved already. But I do not circulate amongst this part of the population, and I know their viewpoint only from secondhand sources. Nevertheless, I see how they, like most of us, are shackled by everyday economic pressures.

Many a conversation turns to the prospects for change to occur. How might a breakthrough arise, an opportunity to move beyond entrenched positions, to make some apparently urgently needed and fundamental shifts in resource extraction and patterns of land use? How might better economic analysis contribute to the environmental cause? Why are efforts at reform thwarted? These are questions best considered from a political economy perspective.

7.6 The Political Economy of Change

In Chapter 3, it was noted that advocates for adopting the constraint that natural capital be maintained intact argued that no paradigm shift was required to support such a stance, but rather that it was consistent with a long tradition in conservative economic thought. While in a narrow sense this may be true, an examination of the political economy of forestry in the Slocan Valley suggests otherwise. Paradigm shifts are needed on several fronts, or, in Schumacher's terms, there is an urgent task of "metaphysical reconstruction" to correct our central convictions (Schumacher, 1973:93-94). Most obviously, a major change is needed in our collective understanding of the human place within the web of life.

Professional foresters, drawing on theory rooted in the 18th and 19th centuries, have, until recently at least, believed that they are maintaining natural capital intact, if not investing in it, by replacing inefficient wild forests with more productive "normal" forests. Natural capital has been narrowly understood as the volume of standing timber. Government, industry, and much of the public continues to hold to the belief that current extraction rates can continue without any consequences to which we cannot adapt, despite overwhelming evidence from more recent ecological knowledge, and from signs provided by the land itself. There are some shifts. Many now advocate moderate reforms, toward what one author has labeled as anthropocentric ecosystem management, in contrast with the ecosystem-based management approach advocated by SFF and Grumbine (1994). The former focuses primarily on providing for existing human uses of resources while attempting to take into account ecological and social considerations. Yet such a stance is insufficient, in the long run, to ensure maintenance of ecological integrity. It embodies the doctrine of final causes inherent in the humanistic approach, asserting that "the features and objects of the natural world were created primarily for the benefit of humanity...fostering the humanistic belief that nature is ours to control" (Stanley, 1995:257). Nature is likely to be unable to meet the demands of a management approach where maintaining current resource flows remains the primary objective.

A more fundamental shift is required toward biocentric ecosystem management, such as SFF's ecosystem-based planning approach. In this latter perspective, protection of ecological integrity is paramount, and human use of resources must be constrained to fit within ecological limits cautiously set (Stanley, 1995:256; Grumbine, 1994). That said, any transition period must recognize and address human needs and motivations if it is to have society's support.

To make our society and economy fit as a part of nature, rather than outside of nature, fundamental changes in our political, social, and economic institutions will be required. The claim by Burda et al. that there is no political space in BC to explore alternatives to existing corporate tenures and industrial forestry (Burda et al., 1997:99), certainly appears to be true in the case of the Kootenays. All attempts at substantive reform have met with failure, leaving 35 people to be arrested for civil disobedience over the summer of 1997, while hundreds of others took time from their lives to help organize or participate in protests. The courts have, with the notable exception of Justice Parrett's November 1997 decision, unfailingly protected the interests of Slocan Forest Products and the Ministry of Forests. The courts have shown little capacity to entertain arguments based on ecological considerations, despite Canada's ostensible commitment to a solemn Convention on Biodiversity. The courts' actions are entirely consistent with the legal system's role within the market state of facilitating and guiding economic growth, and of maintaining existing economic and political structures. The courts have presented themselves to the broad public as neutral arbitrators, a role that they cannot, in truth, play, given the many non-neutral assumptions implicit in our legal system. These assumptions are a product of the economic system, and so the courts are inextricably bound in the task of protecting existing economic arrangements (M'Gonigle, 1986:255-260). Yet there are signs of movement from the highest court of the land, that the model where courts are seen as uncompromising guardians of the status quo may overstate the case--witness the recent *Delgamuukw v. British Columbia* decision which significantly enhances the power of First Nations to influence resource exploitation in their traditional territories, notwithstanding corporate interests.

Given that the changes sought by a good portion of the Valley residents are fundamentally incompatible with the status quo, it is not surprising that there is little political space within which to reform forest management, and that existing institutions have blocked change and refused to evolve when faced with the imperative for change. The large, highly capitalized and vertically integrated operations characteristic of BC's forest industry require massive throughput of resources to be profitable in a global market driven by an incomplete and distorted price system, and the timber resource is already overcommitted. There is no future for such large corporations if ecosystem-based planning and ecoforestry reduced the rate of cut by roughly an order of magnitude, especially if society has an objective of providing for the employment of its members. The multinational timber industry and Slocan Forest Products cannot allow such changes to occur. They can and must therefore marshal their resources to impede such changes, be it through participation in industry public relation efforts, by turning to the courts to get injunctions so as to proceed with their plans, or by suing protesters for damages in an effort to increase the costs of future dissent. Organized labour, while becoming a progressively weaker influence as mechanization reduces jobs in the forestry sector, still largely benefits from the status quo. IWA members receive high wages relative to the educational attainment and the skills required for the job, while prospects for equivalent employment outside of the forest industry are slight.

The BC government relies on revenue from the liquidation of its forest assets, yet this reliance is overstated. Most, if not more, of what it thereby earns it spends on supporting the industry (Mascall, 1997), and the employees of the Ministry of Forests, the silvicultural crews, and the forestry consultants each have a vested interest in the status quo. The government has long served to further corporate and labour interests (Wilson, 1986:35). Wilson's assessment of the forest conservation debate from 1935 to 1985 appears as relevant today as it was for the half century he examined:

> That story, in the final analysis, describes a fairly typical slice of liberal-capitalist political life. Those with political-economic power controlled the agenda. Bias was mobilized against those who might have been expected to challenge that control...some issues were organized into politics, while others were organized out. The collective political imagination was not very fertile; consciousness of costs, benefits, risks and alternatives remained rather low (Wilson, 1986:41).

The effort then to base economic analysis on the natural capital metaphor is useful in theory, but severely limited in practice. Those economists whose perspective is granted societal legitimacy have rarely recognized that economics is "the indispensable servant of the sociopolitical order to which it ministers" (Heilbruner and Milberg, 1997:127). Conventional economic analysis in BC to date has legitimized industrial forestry, even if this has meant breaking a long-standing tradition in economic thought which counsels against treating the proceeds from liquidation as income. Of course, in actual application, this rule has been perhaps most frequently observed in the breach rather than through application consistent with theory.

The revisions I have proposed, to account for natural capital depletion and ecosystem-economy linkages, if applied as intended, would reduce the legitimacy accorded to the industrial forestry economy, and would thus contribute to change. However, such revisions are easily co-opted, or weakly interpreted, and they only go so far. Most likely they would help to generate pressure for moderate reform such as a quicker decline to the Long Run Sustained Yield. They would also force better representation of the ecosystem-economy linkages. Yet they fail to ensure that the absolute dependency of the economy on the biosphere and local ecosystem integrity is recognized. They fail to require a wholesale abandonment of the growth imperative. They do little to address entitlements, issues of power, distribution of benefits, or the need to shift to a society in which the pursuit of happiness is decoupled from material consumption. Therefore, a profound shift in economic thinking is also required. From various different perspectives then it is clear that maintaining natural capital in a sense that truly helps protect ecosystem integrity requires a paradigm shift in thinking--and feeling. And once that paradigm shift occurs, the natural capital metaphor is itself likely to be redundant or deficient.

It would be tempting to end this study with some facile policy recommendations. For instance, I could suggest that the AAC be dropped to the LRSY in four years, during which time ecosystem-based plans would be devised, and a new, ecologically cautious AAC set, to be followed within the decade. Corporate tenures should be replaced with community forest trusts along the lines proposed by Burda et al. (1997). To make such recommendations would be to display the naiveté concerning power that is all too common within ecological economic thought (Gale, 1996). Reading through the work of prominent ecological economists such as Costanza while working on this case study in the Slocan Valley has been instructive. For instance, Costanza and Folke propose a 12-step process for integrated ecological-economic modelling to achieve consensus decisions by the involvement of stakeholders in a roundtable (Costanza and Folke, 1997:60-62). Would they propose such a process if they had participated in the CORE program and witnessed its limitations, and then seen how most of the substantive CORE proposals were watered down through the subsequent implementation process? Economists and other social scientists have a responsibility to recognize that they often operate in a policy arena where, as recently described for BC, existing institutions, instead of reconciling conflicting goals,

> ...often worsen the conflict; instead of providing helpful information, they conceal it; instead of dealing with collective needs, they prevent their satisfaction at exorbitant cost. Worse, they stifle community spirit and good will. As part of this general failure, they block efforts to provide for the individual and collective needs of future generations (Cohen et al., 1996:165).

This is not to adopt a nihilistic attitude denying all opportunities for change. At various times, the liberal capitalist state, or, as I prefer to think of it, the modern industrial market economy, faces a crisis of legitimacy. During such moments, typically quite brief, there is an opportunity for innovation and substantial change. For such change to go in a more ecological direction, and for it to lead to higher levels of social well-being, the theory to back up such change, and the political support to create the impetus for it to occur, must already be in place (Hay, 1994:218-220). Yet even then, prospects for change are limited.

The state's ability to proceed with fundamental change is severely constrained by the dictates of participating in the global economy. Given the difficulty of pursuing fundamental change, the state can react by crisis displacement, token gestures, symptom amelioration, or scapegoating (Hay, 1994: 221). Vested interests may be caught off-balance for a period, as they were during the initial wave of environmentalism in the 1970s. But in short order, these interests become organized, they resist changes, and they seek to obtain weakened regulations, standards and enforcement (FitzSimmons et al., 1994:199). The meanings of various environmental concepts and terms are fought over, shifted and transformed to neutralize their implications for change (Gismondi and Richardson, 1994:248). Thus, while the Clayoquot protests and other similar events created intense pressure for wholesale change in the province's forest practices, government and industry successfully deflected such pressure through a campaign centered around the Forest Practices Code, the Protected Areas Strategy, the Commission on Resources and the Environment, and an intensive public relations campaign. These initiatives left industrial forestry and corporate tenure essentially unchallenged (M'Gonigle, 1997). More recently, the Premier's labeling of environmentalists as "Enemies of BC" illustrates the use of the scapegoating technique. Thus, even when a crisis of legitimacy exists, and when the advocates of a new approach are organized and have a theoretical construct available to legitimate their demands, the prospects for a fruitful outcome remain uncertain.

Unfortunately, these problems may prove intractable. Dryzek identifies five limits to the environmental problem-solving capability of liberal democracies:

- power relations are inevitably skewed, in favour of the profit-oriented interests of business;

- environmental problems are identified and disaggregated on the basis of the particular interests of affected parties, without necessarily adding up to a general ecological interest;

- the political currency of liberal democracy is focussed on rewards to identifiable interests, a reward system which does not operate to provide effective management when ecological problems are complex and pervasive;

- the time horizon of liberal democracy is as short as that of the market; and

- liberal democracy is addicted to growth to avoid addressing inequalities (Dryzek, 1994: 180).

Each of these can be seen to operate to a lesser or greater extent in the case of the Slocan Valley. It appears that effective reform will require broadly based and well organized political support, applied at a moment when government is under intense pressure to respond to serious crisis engendered by status quo policies. It will be difficult for the Slocan Valley to achieve such reforms if there is not similar pressure from other areas in the province.

Ultimately both the ecological crisis and the crisis of legitimacy will deepen. Wood supply will drop further, timber workers will be thrown out of work, and ecosystem degradation will intensify. These crises will draw out the best and the worst in people. The ranks of those committed to change will likely swell, and their knowledge of the ecological basis for change will likely deepen.

We can only hope, both for BC's sake and for that of the life inhabiting the region, that the number of irreversible thresholds crossed will be limited. Such crises will come in waves. If we react appropriately to an early one, the quality of life BC inhabitants will be able to enjoy will be significantly higher than if we continue our worst excesses. This is a transition that previous forest-dependent societies have mostly failed to make without great social disruption, yet each day that passes reduces options for the future (Binkley, 1993:47).

It seems probable then that the Slocan Valley will be unable to ensure that logging proceeds in a manner which protects natural capital or ecosystem integrity until more fundamental political and institutional changes begin to occur. A Polanyian perspective would suggest that the liberal market state embodies a trajectory leading to social instability and ecological degradation. While countermovements to protect society and land from the corrosive influence of the unconstrained market may slow the rate at which society and the earth unravel, true improvement may prove impossible until, in Polanyi's terms, the market is re-embedded in social relations, and land is no longer treated as a commodity (Polanyi, 1947). To achieve these goals, society will need to become more transparent, just, and participatory. The individualistic ideal pervading the assumptions upon which our institutions have been built (M'Gonigle, 1986:244) must be replaced by a more realistic model, one which would enable the recognition of the individual as a person-in-community (Baum, 1996:34). In a similar vein, communities and their economies need to be embedded in local ecosystems in a way that allows ecological integrity to be maintained. The community and its economy need to respect ecological limits as a matter of principle and ethics, not of consequence and calculation. Yet in an era when the trends are towards globalization and removal of local controls, it is exceedingly difficult to build up local institutions and means of governance to ensure local sustainability (Lang and Hines, 1993; Ostrom, 1990:21-23; Daly and Cobb, 1994:209-225; Røpke, 1994:20-21).

Some ecological economists have sought to value global ecological services, lamenting the "near total lack of public appreciation of societal dependence upon natural ecosystems... [which is] a major hindrance to the implementation of policy designed to safeguard earth's life-support systems" (Daily, 1997:xv). The above analysis of the political economy of the Slocan Valley puts the potential for reform of economic analysis to incorporate strong sustainability into context. Incorporating a sustainability criterion or objective is doubtless a useful endeavour, but one would be naive to expect significant results without addressing a host of other barriers to strong sustainability. Much of the public deeply appreciates their dependence upon nature. It is not a price tag or a need for better accounting that is an impediment to change. Rather, it is the power of certain existing institutions, incentive structures, and private interests.

It is also by no means certain that the valuation of natural capital will not be used in a way that is at cross purposes with the maintenance of ecological integrity. For instance, the US Forest Service was accused of mismanaging the nation's public forests when it was revealed that more money was spent on forest management activity than revenue was derived from stumpage and from other timber-related revenue (see, for instance, O'Toole, 1988, Chapter 2). The Forest Service reacted by estimating the value of non-timber outputs from national forests, such as recreation, and showed that the total benefits were 7 times greater than the cost of management, thereby, they argued, justifying the cost of their management efforts (US Forest Service 1987; Gray, 1994). Yet the management efforts of the forest service in most cases interfere with, rather than contribute to, the maintenance of ecological integrity and the production of non-timber outputs (and, in some instances, future timber outputs).

7.7 Theory vs. Action

Despite the temptation of summer sun in the mountains, and despite invitations to join another hike, or yet another protest, I sit at my desk in a windowless office in Nelson. I pore over the economics literature, comb through government and industry reports, and seek to find the flaws, biases, and shortcomings in economic analyses that suggest that we have no alternative but to keep clearcutting watersheds, to continue liquidating the old growth. At the same time, there is deep despair in my heart. I too have exhausted all avenues. I don't believe for a moment that correcting economic analysis to account for natural capital--such cold terminology which fails to capture anything of the wealth or spirit of the stand of old growth at New Denver Flats, or the taste of the water I enjoyed from Perry's Ridge--I don't believe that correcting the methodology will change what happens on the ground in this Valley, at least not for the critical next few years. Vested interests, recalcitrant bureaucracies, and an economy dependent on uninterrupted resource flows, even if this means destroying its very foundations--all conspire against respecting ecological limits. Many before me have sought to point out how economic theories and analysis have failed to recognize our ultimate dependence on nature, yet so little has changed.

In my more pessimistic moods, each day in the office feels like a waste. Of life: we may be the last humans to know an Earth still worth living on, and here I turn my back on celebrating these mountains. In the beautiful Kootenays, one can still be ignorant of the rapid disintegration of the web of life. A hike in many of these mountains is still solace to the soul, where industrial forestry is but a blotch in the distance--I yearn to be out there! Of effort: would I not better spend my time organizing protests, or going to jail, like 76-year-old Jack Ross, who, suffering from Parkinson's Disease, was held for two months without trial in a maximum security prison for refusing to sign an undertaking not to protest on the road again. Should I fast in support of the hunger strikers, join the daily noon walk around Nelson with the placard announcing the progression of Eloise's hunger strike, or come up with my own initiative? Should I take my commitment one step further, like Matt, Andrea and Jen, who locked themselves to logging equipment, forcing the police to use a grinder to set free the equipment which so easily tears through the woods? Yet these valiant efforts appear to have no payback but a month's accommodation at Her Majesty's penitentiary. I cannot shake the feeling, sitting in this office, door closed to the buzz of activism outside, that this academic endeavour feels hollow, self-indulgent, and, thinking as an economist, a poor investment of what little time I have to use. I am sitting on a deck chair of the Titanic, arguing with imaginary adversaries over the appropriate prices and accounting practices to record the calamity which is about to ensue. I seek this price in the vain hope that if I can run up to the bridge with the correct figure the first officer will see that it would be more profitable to avoid icebergs. Yet I know that the first officer will not even lend us an ear, for he believes his vessel unsinkable.

May these feelings be wrong.

Chapter 8 Conclusion

This study has advanced considerable evidence that economic analysis, as carried out in BC in the context of timber extraction regimes and forest land use, is inconsistent with a long standing tradition within economic theory and reporting: income should be calculated and reported on the basis of capital remaining intact. This definition has arisen for pragmatic reasons, and is commonly understood to capture one of the fundamental requirements of prudent economic behaviour.

This long-accepted understanding of income, succinctly captured in a definition by Sir John Hicks, must be reinterpreted now that we live in a world that has reached certain ecological limits. A broadened notion of capital must be invoked, one which moves beyond manufactured to natural capital, and thereby includes a whole range of stocks not produced by humans. Correspondingly, the notion of the "productivity" of the capital stock must acknowledge that, far from producing merely a single desired commodity (timber), natural capital generates many joint products, producing diverse benefits including timber, soil erosion control, biodiversity, and water, to name a few. However, in BC at present, the stream of revenues generated by liquidating old-growth forests is treated as if it were income, rather than as the proceeds from liquidating an asset in a way that will impair future flows of commodities and ecological services.

Recently the state, as the body responsible for renewable resource management, has ostensibly attempted to obtain the information required to factor social and environmental considerations into the decision-making process, through a Multiple Accounts Analysis framework. Unfortunately, the multiple accounts framework used in BC is presently defective. This study has documented how it unrealistically portrays economic flows as largely unaffected by ecological change. Together, deficiencies in income reporting and in

MAA as they are currently applied not only involve a failure to use best practice when applying economic theory, they also are inconsistent with the government's stated commitment to sustainable development.

To correct such shortcomings, this study reinterprets the Hicksian definition of income in the context of a world close to ecological limits. It becomes clear that, due to severely limited opportunities to substitute natural capital with manufactured capital, and due to the necessity for a prudently skeptical attitude toward opportunities for technological progress to overcome the consequences of natural capital depletion, the management objective should be to require that society pursue strong sustainability, whereby natural capital is maintained intact. From this basis, it is possible to derive rules to guide human use of natural capital, and it is appropriate to insist that economic analysis take natural capital consumption into account.

However, a review of the theoretical and practical considerations involved in accounting for natural capital demonstrates that there are intractable problems in completing such a task. A pragmatic approach is required. Thus, it is proposed that the benefits stream from any renewable resource extraction regime be divided by the analyst into those benefits which could be obtained if extraction maintained natural capital intact, and those that involve extraction beyond such levels. It is proposed that the above requirement be met by dividing and labeling the benefits expected from a proposed extraction regime into interest and depletion streams.

This study also sets out revisions to the multiple accounts framework in order to better reflect the nature of the dependency of the economy on ecosystems and the services they provide, and to ensure that the analysis recognizes the imperative to maintain natural capital intact. The existing environmental account required under the multiple accounts guidelines portrays the environment as an amenity that contributes to human welfare, but that is not essential. In contrast, this study proposes that the environmental account document divergence from the requirements from strong sustainability entailed by the scenario under consideration, and that this information provide the basis for evaluation of the economic benefits and consequences of the scenario being evaluated. Without such information, it is shown, the analysis is partial and biased. This study further suggests that, to be consistent with stated commitments to sustainable development, matters of equity need to be considered in the multiple accounts framework. A new account should be added to the framework to assess whether a scenario contributes to national or global sustainability.

In order to evaluate various scenarios, this study recommends that a base case be defined that is consistent with strong sustainability, against which all other scenarios should be evaluated. This is preferable to the current approach, which requires that analysts take the status quo as a baseline--even if there is considerable evidence that the status quo will not prove to be ecologically feasible.

The changes proposed to both the way in which benefits from unsustainable renewable resource extraction regimes are treated, and to the setup of the multiple accounts, will jointly assist in focusing policy debates on how to shift from resource extraction and land use scenarios which are highly unsustainable, to regimes which respect ecological limits. By way of contrast, current methods focus the debate on how to maintain high levels of resource extraction in order to keep enjoying the existing stream of jobs, income and revenue as long as possible. As such, existing guidelines represent an impediment to the achievement of sustainable development.

This study has acknowledged that there are many complicating factors involved in making such changes. For instance, there are scientific and value questions involved in defining a resource extraction regime which would be consistent with strong sustainability. Some may suggest that an extraction regime based on the currently approved AAC and strictly adhering to the Forest Practice Code, in the context of other provincial initiatives such as the Protected Areas Strategy, would be sufficient to maintain, if not invest in, natural capital. This study has reviewed the evidence presented by various critics of the BC forest industry, and has found compelling evidence to suggest that recent policy initiatives are largely ineffective, and, if anything, intended more to deflect public opposition than to achieve better protection for natural capital stocks. Yet even if such policies were better designed and more effectively implemented, the underlying approach is flawed.

A limited review of the conservation biology, landscape ecology, and forest ecology literature, demonstrates that the requirements of maintaining the natural capital of the forest land base intact are much more complex, and stringent, than current government initiatives recognize. A new approach is needed, one which defines *a priori* the conditions for maintaining ecosystem integrity. Ecosystem-based planning is necessary to maintain landscape level connections and processes. This type of planning zones much of the landscape off-limits to timber extraction. Forests under ecosystem-based management should contain the same structures and legacies as their natural counterparts. Soil productivity, and genetic, species and habitat diversity should be maintained. Furthermore, to allow for harvested stands to pass on ecological legacies, to maintain soil productivity, and to provide room to maneuver in the context of uncertainty and surprise, significantly less than the annual increment of timber should be extracted.

This study has shown that ecosystem-based planning provides a foundation upon which to differentiate income from natural capital depletion. The analyst can divide the stream of benefits in two: those benefits consistent with maintaining natural capital intact, and those benefits likely to be of a temporary nature because they are derived from depleting natural analysis are in vain. This is because the economic analysis undertaken by the US Forest Service is likely to be deficient in many of the same ways as it is in BC's case.

While the incremental reforms advocated in this study address one aspect of sustainability by accounting for the depletion of natural capital, they do not address the broader ecological economics critique on the "quality" of the economy, or the necessity of addressing issues such as equity. The incremental adjustment suggested in this study neglects important linkages such as the connection between individual well-being and dignified versus dehumanizing work. It ignores factors contributing to social cohesion and the accumulation of social capital. Levels of social capital and the degree of social cohesion and individual well-being can have important ecological consequences, and one option might be preferable to another despite generating lower levels of material wealth, because it would provide greater social cohesion. The modifications proposed here would miss such important differences. These limitations point to the need for new approaches to economic analysis which integrate the diverse social and ecological values and findings of ecological economics. The incremental adjustments suggested here, by themselves, will not take society very far down the path to strong sustainability, but at least analysis conducted in a manner consistent with the main findings of this study will not portray unsustainable options with unrealistic optimism.

While this study has not involved the actual application of the proposed means of accounting for natural capital and of improving the MAA framework, the recommendations presented in this study were derived from the context of a case study in which I was closely involved. The case study influenced my theoretical work in two chief respects, one ecological, the other socio-political. By living in and traveling through the Slocan Valley landscape, I saw the immense practical and theoretical difficulties involved in accounting for natural capital depletion or for environmental degradation. This focussed my efforts on moving beyond simplified interpretations of the imperative to "live off the interest", the economist's contribution to the rules of sound resource stewardship. I kept thinking back to the steep mountain walls, the small streams, the valley bottom orchards, and the wildlife, and questioning how all these could be taken into account. The case study thus enabled me to sharpen my criticisms of currently used methods of economic analysis and theoretical proposals to address natural capital depletion. It also required that the practicality of recommendations be kept in mind at all times, to ensure that proposed methods not be analytically onerous. These two outcomes were of sufficient value in themselves to make the case study approach worthwhile.

The case study also forced me to consider how it could be that the arrest of 35 residents seeking to protect their forests and watersheds during the summer of 1997 could have no apparent effect. The case study thereby enriched this study by making clear the complex ecological, economic, social and political landscape that is often hidden behind cold tabulations of jobs, income and revenue considered in multiple accounts studies. Such studies make it clear that economic analysis has been used to justify status quo policies, to make them take on an appearance of neutrality and inevitability. It helps explain why the tremendous effort to broaden the scope of economic analysis beyond mere timber in the US national forests, as documented by Healy and Ascher (1995), has had such disappointing results. When the forest, conceived as natural capital, is viewed through the economist's lens, there are at least three filters that can be used to colour the picture and frame the debate. One filter captures the perspective of those who see the forest as a complete bundle that has diverse, interrelated components providing a complex set of ecological services and desired flows. Another filter blurs this earlier picture, but makes the Valley's timber resources and their potential for generating corporate profits jump to the foreground. Finally, there is the filter that captures the perspective of those who are dependent on the timber industry, yet who are exposed to some internal conflict, as they may insist that more of the proceeds of exploitation should remain in the Valley, and as they are also part of the Valley ecosystem. Given that one of these filters must be chosen, the analyst can do little to lessen conflict between the three.

The case study helped to clarify the political economy within which economic analysis takes place. It suggests that vested interests, institutional arrangements, power differentials and other factors make change towards more sustainable use of renewable resources extremely difficult. Thus, the reforms advocated in this study, while helpful, do not represent a panacea. They may be ignored so that future analysis will be carried out as at present. If not ignored, the proposed reforms may be weakly interpreted so as to weaken the potential for criticism and to justify at best minor adjustments to the status quo, but nothing further. If the reforms are effectively implemented and interpreted in a manner consistent with the interest with which they were advanced, the results of the analysis may not have much of a bearing on actual political outcomes. If protests by hundreds of citizens and the arrest of 35 individuals do not result in changes to government policy, then there is no reason to expect that more sanguine numbers in a study will make government and industry modify existing plans, especially as they face powerful forces generated by competitive markets and the narrow interests of investors. However, these real-world considerations are no excuse for the continued application of economic analysis in a way that is inconsistent both with a long strand in economic thought, and with more recent insights generated by ecological economics. It is therefore appropriate and necessary to continue to research improved means of accounting for the depletion of natural capital and of incorporating the societal commitment to sustainable development. There will be no definitive result to such a research agenda, and therefore application of already available insights should be undertaken without delay.

Advocates for such an approach should also recognize the costs or long-term consequences of emphasizing the natural capital concept and metaphor. First and foremost, it must be recognized that natural and manufactured capital differ fundamentally. The former is not produced by humans. Our abilities to manage and manipulate natural capital are severely limited; more apt is to recognize that we can merely manage human activity--and at this latter task, we are currently sorely deficient. The natural capital metaphor may help commoditize nature and legitimize efforts to bring more of nature under market control as a means to improve allocation and efficiency of resource use. Such a trend would have serious ecological, social and human rights implications. Speaking of natural capital may render nature less sacred and mysterious--two qualities that may in fact be necessary to reach a more lasting relationship with nature, in which humans see themselves as part of nature and act accordingly. The natural capital metaphor fits within a humanistic approach, dangerously suggesting that nature is here for human use and enjoyment, allowing society to remain complacent despite the great proportion of nature's output currently being appropriated by humans, and despite the extent to which we manipulate ecosystems.

At best, then, economic analysis based on maintaining natural capital intact is a transitional tool, perhaps essential until a larger social, political, and metaphysical construction has taken place towards a conserver society content with a modest life, in which the path to human well-being is not seen as directly related to the contents of the average shopping cart. Therefore, ecological economists need to transcend the natural capital metaphor to take on the economic questions raised by the likes of J.C.L. Simonde de Sismondi, John Ruskin, Karl Polanyi, E.F. Schumacher, Gandhi, and more recently, feminist economists, to address issues of needs, of quality of work, or human-scale economics, of gender... They need to recognize that prospects for sustainability depend heavily on reforms that build on the interest of those who identify themselves with their valley, their rivers, who see their future as being one with the future of the landscape. Local populations also have the benefit of being able to draw on their knowledge of the characteristics and behaviour of local ecosystems, of linkages and interdependencies.

Due to the critical rate at which ecosystems across the globe are unraveling, ecological economists have admitted that their field has a very limited lifespan within which to be relevant so as to result in fundamental change. If ecological economists truly wish to take this observation into account, then they need to realize that ecological economics needs to become more activist. It needs to better understand why local populations lose control of local resources in favour of distant markets, large corporations, or government bureaucracies. It needs to understand the forces acting against activists and local populations who seek to ensure sustainability of resource exploitation and utilization in their regions. It needs to focus on practical matters. It needs to become an economics that inspires people to live differently and to change the society of which they are a part.

From an ecological perspective, and therefore, by implication, from an economic perspective, it is the next 20 years which are of critical importance. In the case of BC, until the Ministry of Forests takes on economic analysis as if it were an agent dealing with the broader public interests in all the benefits derived from and provided by the forest estate, rather than an agent seeking to maximize the private benefits available to those involved in timber extraction and processing, economic analysis will fail BC's forests and the people who depend upon them. Meanwhile, mobile capital may move on to exploit the next landscape, until it has consumed the very basis necessary for production. Flawed analysis allows society to blindly enjoy temporary high levels of material consumption; a burst of wealth which creates expectations that make the transition to sustainability all the more difficult. The Ministry of Forests has a responsibility in its analysis to be clear and explicit about the degree to which streams of benefits are based on the depletion of timber stocks, and to detail the long term costs of such depletion. It needs to admit that its AAC figures, and hence projections of future benefits, are highly optimistic when compared to those generated under an ecosystem-based approach involving the precautionary principle. It further needs to admit that the currently high rates of extraction can only be maintained at the expense of future flows of other, often unpriced, outputs and services provided by the natural capital of the forest.

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Appendix 1: Accounting for the Depletion of Natural Capital

This appendix examines the difficulties that arise when one tries to account for natural capital depletion in economic analysis, and critically reviews various techniques found in the literature for taking natural capital depletion into account. In the following review, a large number of approaches are considered, each intended to accomplish the same goal: putting a value on natural capital.

The differences between the approaches are not as arbitrary as they might at first appear. They arise because analysts approach the question from either the supply or the demand side. From the supply side, analysts suggest techniques that involve determining:

- how much it would cost to provide replacement natural capital;
- what would be the cost to the economy of losing a given amount of natural capital; or
- what would it cost in foregone economic benefits to meet a given standard or level of natural capital.

On the demand side, the questions are:

- how much would society be willing to pay for a given level or quality of natural capital;
- what would society accept as compensation for a lowered level of natural capital; or
- what changes in price levels of goods highly affected by environmental quality are observed as a result of changes in the quality of natural capital.

Under certain conditions, the values assigned to natural capital by these different approaches would tend to converge. Such conditions include perfect capital markets, perfect foresight, and a pre-assigned terminal value for the natural capital stock at some given point in the distant future (see Burmeister and Dobell, 1993 [1970], Chapter 11, for an early review of optimal economic growth models and some of the required conditions).

However, these conditions do not apply in the real world, where natural capital stocks are being rapidly drawn down, where perfect markets and information do not exist, and where ecological knowledge is limited and subject to uncertainty. Therefore, it is important to assess proposed techniques for natural capital valuation against current conditions and policy realities.

1. Problems That Arise when Accounting for Natural Capital

As was seen in Chapter 3, capital theory, even when restricted to the more manageable world of manufactured capital, involves a number of difficult practical and theoretical problems (see also McElroy, 1976; Crocker, 1995; Hulten, 1996). Applying capital theory to natural capital compounds these difficulties with a host of other problems and complications. A brief review of some of the issues that will be faced by an analyst who intends to account for natural capital in his or her economic analysis is in order, before reviewing different techniques proposed to account for natural capital.

1.1 Problems of Aggregation

Many proposals require that the analyst aggregate various stocks of natural capital. Yet natural capital is heterogeneous, interdependent and indivisible (Norgaard 1993:279; UN, 1993:11). A wetland cannot provide high levels of environmental service if the watersheds which feed it are damaged beyond a certain point. The wetland cannot then be valued independently of the state of such watersheds. The ecological integrity of the watershed in turn may depend on the wetland providing habitat for species whose place in the food web ultimately affects the health of the watershed ecosystem. Wetlands and watersheds are thus interdependent and indivisible, and cannot be valued separately, yet the two forms of natural capital are heterogeneous, and thus difficult to aggregate. Page (1991) suggests that much of our difficulty in conceptualizing ecological-economic linkages, and thereby accounting for natural capital, result from our use of highly individuated tools to approach non-individuated problems. This is a problem that ultimately cannot be satisfactorily addressed.

1.2 How Are Capital Gains and Losses to Be Valued?

Many of the proposed approaches to accounting for natural capital which build on Hick's definition of income involve valuing stocks of natural capital at the beginning and at the end of a given accounting period, thereby capturing any changes due to investment in or depletion of natural capital. However, where stocks of natural capital are large, and changes in the stocks of natural capital small relative to changes in market prices, the signal given by the market value of the natural capital stock may be misleading. It may be more responsive to capital gains and losses generated by changes in market prices than to actual depletion (El Serafy, 1991:249). Thus, if timber values skyrocket due to a sudden housing boom, while during this same time period forests are being overcut, the current market valuation of the now reduced inventory of standing timber may actually increase, allowing the decision-maker to erroneously conclude that forest resources are subject to effective stewardship.

1.3 Applying Old Tools and Concepts in a "Full" World

Hick's definition of income, the System of National Accounts, and tools of economic analysis generally were developed at a time when the economy was not pressing against ecological limits. Rather, the concern was to increase the stock of manufactured capital, to increase the use of "unharnessed" natural resources. Therefore, such tools and concepts are often not suitable for conditions now prevailing (Repetto et al., 1989:1; Friend, 1991:93).

1.4 Techniques Which Rely on Discount Rates

Many of the methods suggested to account for natural capital involve examining changes expected in future revenue streams as a result of varying natural capital stocks. To bring such revenue streams into the present usually requires the use of discounting. A substantial literature exists which details how discounting can bias decisions against sustainable outcomes by undervaluing losses from environmental degradation which takes place in the mid to distant future. For instance, the loss of the entire world's GNP 100 years from present would translate into a loss of about one million dollars today using standard discount rates (D'Arge et al., 1990, cited in Brown, 1992:210). At the same time, use of low discount rates in project evaluation to address such sustainability concerns could increase investment in projects and infrastructure which cause ecological damages, especially where the costs of such damages are not included in project appraisals. This leads to the conservationists' dilemma: high discount rates encourage liquidation of natural capital; low discount rates encourage environmentally damaging projects and growth. This dilemma occurs partly because, in using discounting techniques for questions of sustainability, economists have not differentiated between the efficient allocation of the current generation's resources vs. equitable allocation of resources between generations (see generally Norgaard and Howarth, 1991).

Resolving the discounting issue is beyond the scope of this study, but it is important to note that any procedure to account for natural capital which relies upon bringing future income streams into the present will face the problem of specifying an appropriate discount rate. Furthermore, when natural capital depletion and environmental degradation costs are estimated and included in the analysis, low discount rates are not likely to cause a boom in projects which harm the environment, so the conservationist does not face a dilemma: low discount rates are preferred.

1.5 What Is to Be Valued?

In accounting for natural capital, one faces the difficult question of what it is that one seeks to value: stocks or flows. And if stocks, is it all stocks of natural capital, or selected stocks of key importance? The former is impractical, while the latter presents the danger that one might focus on those resources which have market values (such as timber) and neglect those aspects of natural capital which have a critical but indirect bearing on the economy and human survival (such as the ozone layer). Economic analysis could then suggest that natural capital is being maintained, even as the requirements for sustainability are being destroyed. From this observation, some researchers argue that all natural capital assets should be valued (Dasgupta et al., 1995:126).

Others argue that it is best to account for natural capital by considering not the stocks of natural capital, but rather the flows generated by the stock of natural capital. From a stock perspective, one could evaluate forest capital in terms of the value of standing timber, of steep slopes protected by forest stands, of soil, of wildlife species and populations. From a flow perspective, natural capital could be valued on a narrow commodity basis in terms of cubic meters of timber, furs and bush meat, etc. that can be extracted every year. Or, flows subject to valuation could be expanded to include water purification services and nutrient cycling services, as was done recently for the global value of ecosystem services (Costanza et al., 1997). El Serafy argues against attempting to account for all natural wealth:

> I submit that we shall never be able to value a complete list of the *physical* stock of natural resources extant at any point in time, let alone attach a *money value* to them in order that we might capture the annual changes of such a value in the flow accounts...What is feasible...[is to be] content with adjusting the conventional accounts, particularly *income*, to reflect such partial degradation. Forestry, fisheries, petroleum and other minerals singly or severally, play a formidable role in the prosperity of certain countries whose national income measurement should reflect the degradation of their natural resource base to the extent that those

> resources are economically significant for the countries concerned (El Serafy, 1991:248).

1.6 Accounting for Conversion

Natural capital is often converted into cultivated capital. Old-growth forests are cut and replaced with managed plantations. Prior to the recent explosion in ecological knowledge, and particularly in research on ecosystem simplification, such conversion could have been seen as maintaining natural capital intact. For reasons explored in Chapter 3, conversion is perhaps best seen as involving substantial decline in natural capital, as cultivated ecosystems, especially monocultures, involve lower levels of ecosystem function; they depend on surrounding more natural landscapes for their continued viability; they are not as resilient as natural ecosystems, and their brittle character requires use of inputs to sustain resource flows; and typically they do not contribute to the maintenance of biodiversity.

1.7 Maintenance of Natural Capital Inadequate

Starting with Hick's definition of income, the economist may well accept the need to maintain natural capital intact. Yet over much of the globe, current levels of natural capital are likely to be insufficient for long term ecological viability. Thus, if one manages so as to maintain populations of BC grizzlies at current levels, conservation biology informs us that, because of habitat fragmentation, we may be dealing with populations with inadequate genetic basis for long term viability. The bears we have with us now may well be "ghost bears" whose extinction is now inevitable (Grumbine, 1992; Quammen, 1997). In such instances, investment in natural capital (or further restraints on current economic activity) may be required to rebuild stocks to viable levels, before one may conclude that natural capital will be maintained intact.

1.8 Spatial and Temporal Considerations

Maintaining natural capital involves both temporal (Norgaard 1993:280) and spatial constraints (von Amsberg, 1994:138). Ecosystem-based planning, for instance, requires that certain sections of the landscape be set aside as old growth nodes, as riparian zones, as cross-valley corridors, etc. It also requires that the landscape be managed to provide for appropriate age class distribution, e.g. that a certain amount of forest be old growth, that old and young forest be distributed in certain ways across the landscape, etc. These imply extraction restrictions. If natural capital is valued on the basis of the output of marketable resources, areas set aside would be deemed to have no value as natural capital, as no marketable resources can be extracted if such restrictions are respected. This would lead to the perverse result that depleting such critical areas would show up in the analysis as an inconsequential loss of natural capital. This would encourage exploitation of the very areas that need to be set aside. Yet such analysis would be deeply flawed. An ecologically oriented analysis would recognize that these areas contribute to the long term productivity and health of the entire landscape. For instance, protected old growth nodes provide habitat for insectivorous birds essential to the health of stands where timber extraction is to occur. This suggests that economic analysis must examine extraction at the large landscape level, and take into account the contribution of natural and semi-natural areas to the overall productivity of the landscape. By taking on larger scales and time periods, the costs of depleting an area designated as off-limits to resource extraction would appear on the books.

1.9 Adjustments Not Marginal

Since most natural capital, and the services provided by natural capital, are currently not subject to market transactions, and because the pricing adjustments necessary to help implement strong sustainability would be quite dramatic, the adjustments involved are not marginal, but instead involve a dramatically different set of prices (von Amsberg, 1994:135). This implies that an economy which maintained natural capital would be in a very different state, and would generate different price signals, than it does at present. Some industries would expand, others might disappear, and thus the prices of all goods and services would be affected (Nyborg, 1991:344). Because such price effects cannot be analytically modeled, it is not possible to develop shadow prices which would imply a sustainable outcome. Without such shadow prices, it is not possible to impute a value for natural capital which would result in sustainable outcomes if used for market and investment decisions.

1.10 Strong Sustainability Does Not Imply Constant Manufactured Capital

As argued in Chapter 3, there is no reason to require that the value of the manufactured capital stock remain constant (though there may be some forms of manufactured capital we do not wish to allow to fall into a state of disrepair), nor that any given project create an undiminishing stream of economic benefits. A project could operate for three years and shut down, to be replaced by another. In the aggregate, and at the end of a transition period, some form of sustainability of income flows is desirable, recognizing that sustainable income flows will likely be at much lower levels than present income flows (which are largely based on capital depletion and hence are not true income). While it is consistent with a Hicksian notion of income for one project to substitute for another, and for one stock of manufactured capital to be replaced by another, this is not generally applicable to natural capital. Forest canopies cannot substitute for ozone layers.

1.11 Valuation and Values

Valuation is dependent on the analyst's personal value system, as well as the values of the society to which he or she belongs; valuation cannot be independent of methodology and ethics (Funtowicz and Ravetz, 1991; Funtowicz and Ravetz, 1994; Myrdal, 1990

[1954]:88,96). If society cares deeply about the natural world and sees itself as part of that world, natural systems are likely to be more highly valued than in a society with a utilitarian focus. Economists prefer to rely on market prices for valuation purposes because a market equilibrium is argued to balance all the marginal valuations of individuals at the prevailing price. Hence, individual valuations can supposedly be ignored. Myrdal has exposed various flaws behind such arguments, including the implicit assumption of a social harmony of interests, which in itself entails several value judgments (see Myrdal 1990 [1954]). The value of natural capital is not created and expressed in the boisterous marketplace of Adam Smith's small producers, for the value of the survival of a given species of songbird is of a fundamentally different nature than the value of a dead songbird of the same species to a collector, and one cannot calculate the former from the latter (Funtowicz and Ravetz, 1994:199).

Values assigned to natural capital will also depend on the analyst's belief system. Two analysts, with access to identical information, may come to opposing conclusions about the viability of industrial forestry. If humans are seen to be apart from nature, if nature's role is seen as providing for humanity's use and enjoyment, then industrial forestry, perhaps somewhat reformed, may well be seen as compatible with maintaining natural capital intact, assuming that this latter objective is accepted in the first place. If industrial forestry is seen to maintain natural capital intact there is either no need for valuation, or the observed ecological change does not represent a loss in value. If humanity is seen as inseparable from nature, either values assigned to natural capital will be high, or the valuation endeavour itself may appear as ridiculous as the effort to put a price tag on one's own heart and kidneys (see Sagoff, 1997).

1.12 No Theoretically Consistent Approach

As the review in this subsection has made clear, the analyst is confronted with a host of intractable problems the moment a commitment to account for natural capital is announced. It is not possible to address all of the above problems at once, and each proposed resolution involves a set of assumptions and values (often unstated). Therefore, there can be no correct way to value natural capital or to otherwise adjust economic tools to account for its depletion. Just as with the construction of conventional accounts, any approach to incorporate natural capital into the analysis will involve theoretical inconsistencies. The goal then is to find an approach that is not too analytically demanding, where the values implied are not arbitrary and can appeal to social values that command wide assent; and that provides appropriate signals to those using the outputs of analysis to make decisions.

1.13. Review of Techniques for Accounting for Natural Capital

By reviewing the literature on greening the national accounts, as well as the literature on incorporating sustainability objectives into project appraisal, a number of approaches were identified to account for natural capital. Some of these approaches would have to be modified to be applied at the project level, or to carry out economic analysis of forest land use options. The intent of this section of the appendix is to provide a detailed assessment of the relative strengths and weaknesses of the various approaches, in order to provide background for the proposed method advocated in Chapter 5 and applied in Chapter 6. A summary of the techniques considered below is included in table form in Chapter 5.

1.13.1 A Bioeconomic Approach to Differentiating between Natural Capital Maintenance and Depletion

Drawing on Clark (1990) and precursors (e.g. Faustmann, 1849), one can seek to address sustainability through optimal resource management models. Faustmann sought to determine the optimal rotation age, T, of a forest in which the timber value V(t) depends on the age of the stand, the cost of harvesting is C, and where the instantaneous discount rate is δ. The manager thereby seeks to maximize:

$$PV = \sum_{k=1}^{\infty} e^{-k\delta T} [V(T) - c]$$

which reduces to

$$\frac{V(T) - c}{e^{\delta T} - 1}$$

Maximizing with respect to T requires:

$$\frac{V'T}{V(T)-c} = \frac{\delta}{1- e^{-\delta T}}$$

which is the Faustmann formula (Clark, 1990:268-270).

By rewriting the formula as:

$$V'(T) = \delta [V(T) - c] + \delta \frac{V(T) - c}{e^{\delta T} - 1}$$

we can see that under optimal management, the increase in the net value of the forest over a given time interval is the interest that could be earned if the net revenue from cutting [V(T) - c] were invested at interest rate δ plus the present value of the stream of future revenues from cutting future rotations of forestry stands. The manager therefore seeks to cut the forest at an optimal age, when the marginal increment in value of the standing trees equals the opportunity costs of tying up the investment by deferring extraction for the length of the rotation. So long as the manager can model how the relative growth rate declines with age, given a discount rate, an optimal age can be determined. Cutting the stand on a shorter or longer rotation represents suboptimal management. Thus, with a discount rate of 3% the optimal age in 1967 for the average stand of Douglas-fir was 70 years, whereas, with a discount rate of 20%, the optimal age was 40 years (Pearse, 1967, cited in Clark, 1990).

Many variants on the Faustmann formula have been proposed. For instance, Erickson et al. (1997) seek to relax the assumption of perfect renewability in forest growth following rotation of constant length, to take into account the forest site's need for recovery from soil degradation and the like. The maximization problem becomes considerably more complex, and rotation lengths tend to lengthen, especially when one shifts from the perspective of a single resource owner to a context in which social costs and benefits are considered.

Optimal resource management models typically seek to maximize the present value obtainable through resource extraction and management on behalf of a single resource owner, rather than taking a broader, societal perspective. Furthermore, such models typically do not include explicit recognition of the dependence of the economy on ecosystem services. Often, functions used to model growth and yields turn out to have little to do with actual ecosystem behaviour, or assume that broader ecosystem conditions will remain unchanged. Corrections could be made to avoid the worst of such excesses. However, they still are of no assistance in clarifying what is required to maintain natural capital intact, or what value is to be charged against natural capital depletion. Optimal resource management seeks to maximize the present value of the stream of benefits in the interests of the present generation. Maintaining natural capital intact, and strong sustainability generally, are concerned with constraints on natural capital utilization and with an equitable distribution of resources *across* generations. The two issues are fundamentally different (Norgaard, 1991, 1993).

Therefore, the present generation may seek to maximize the benefits which it derives from timber extraction, subject to the constraint that harvest levels, patterns of land use or other aspects of resource extraction should not cause irreversible changes in natural capital stock or in the services and flows provided by natural capital. Bioeconomic models need to be respecified in a way that explicitly recognizes such constraints, in which case they could be used to help clarify how to treat a stream of benefits which involves natural capital depletion.

1.13.2 Change in Productivity Approach

The change in productivity approach is based on capturing the opportunity costs of degrading natural capital when proceeding with a given project. This technique can also be used to capture the benefits of investing in natural capital. The analyst compares the stream of benefits that would be received with and without the project. For instance, the value of a wetland that is to be replaced with a given development has been assessed at the discounted market value of the fish that will no longer be harvested as a result of the wetland's destruction (Lutz and Munasinghe, 1993:202). Alternatively, the value of a wetland has been tied to the consumer surplus of recreational fisheries supported by the wetland (Bell, 1997:243-254).

Productivity change approaches have also been applied to calculate the loss in natural capital represented by soil degradation. Soil degradation results in lowered crop yields, leading to a loss in welfare and national output (see Bojö, 1996, for a review of applications of this approach).

In simplest form, the productivity change approach can be expressed as:

Value of natural capital depleted = NPV (SEBP - SEAP)

where SEBP = value of sustainable extraction *before* project
SEAP = value of sustainable extraction *after* project

It should be noted, however, that this method is often applied by taking the value of existing or projected harvests, without reference to their sustainability. If harvest levels are not sustainable, then natural capital depletion occurs on both sides of the equation, and the result is erroneous.

When the ecosystem provides services to industry, the productivity change might reflect increased costs to industry of performing a service formerly provided freely by nature, such as waste assimilation. Thus, if a wetland purified water that a factory then used in its production process, the value of the wetland would be equal to the cheapest means of obtaining water of equal purity as that provided by the wetland.

This technique has as advantages its relative simplicity, as market values can often be derived for the forgone stream of income flows without too much difficulty. However, this is based on the assumption that one can predict changes in productivity as a result of ecological change, while in fact such predictions are fraught with difficulties. For instance, what are the effects on fish productivity of destroying 10%, 20%, 70% or 90% of a given wetland? Few ecologists would feel comfortable giving a specific answer to such a question. Because it is premissed on the value of traded goods, this technique fails to capture the value of ecosystem functions which do not provide marketed outputs. Natural capital will therefore tend to be significantly undervalued.

Turning to the Slocan Valley example, the productivity change approach could have the perverse result of putting a zero value on depletion of natural capital in areas which a sustainable forestry regime would declare off limits to timber exploitation. For instance, an ecosystem-based plan might define protected areas where future timber extraction is not allowed. If the economic analysis is carried out at the stand level, there would be no direct opportunity cost in reduced timber production if these areas are cut under an industrial regime, since ecoforesters would not have planned to cut in the protected area. However, this problem would be avoided if the analyst were to undertake the analysis at the landscape and not at the stand level, and if linkages between the ecological integrity of the landscape and the productivity of timber zones within the landscape were appropriately modelled. This is because exploitation of protection zones reduces the ecological integrity of the landscape, and therefore the landscape as a whole would likely suffer declines in timber productivity (as well as other flows and services), particularly over the long term.

It is instructive to examine the result that this method would produce under a fairly common scenario, where an extraction regime leading to natural capital depletion is aggressive, highly profitable, and results in such degraded condition of natural capital that zero economic benefits are provided once liquidation is complete. If we assume further that the sustainable extraction regime produces persistent but limited economic benefits, this valuation technique produces disconcerting results. Because the aggressive regime produces all benefits in the early years of a resource's liquidation, while the sustainable regime spreads out such benefits, this later stream, once discounted, will typically appear quite small, while the former may be several times larger.

Let us add some numbers to the analysis. A forest can either be liquidated all at once, providing a cash influx of $10 000 000, once and for all, but without ever providing any further economic benefit (sustainable extraction after project = 0), or $ 250 000 worth of timber per annum can be extracted in perpetuity. The value of natural capital depleted becomes equivalent to

$$= \text{NPV} \left\{ \left(250\,000 + \frac{250\,000}{1 + r} + \frac{250\,000}{(1+r)^2} \ldots \right) - 0 \right\}$$

If r = 0.05, then we balance an initial profit of $10 000 000 against natural capital worth $5 000 000. According to standard arguments, the "rational" agent would choose to liquidate the natural capital. Of course, we have assumed that depleting this natural capital causes no other downstream effects that would change the productivity of other economic processes. Yet if the forests contributed to either climate stabilization or to the maintenance of biodiversity, it could well be that the loss of this stand of trees could cause slight (but non-measurable) changes in the productivity of enterprises whether nearby or located on distant continents, and, more noticeably, that it would affect the viability of neighbouring forest stands, affect water quality, salmon productivity... The analyst is led into a thicket of unknown and unknowable causal relationships with different time lags. The value assigned to natural capital will often be quite low. This technique is thus very sensitive to the ability to quickly liquidate a resource, the need for sustainable regimes to spread out benefits, its reliance on discounting, and the focus on benefits that can be valued through market valuation. Because of the above problems and limitations, the change in productivity approach is rejected as a means of valuing natural capital in BC's MAA framework.

1.13.3 The Replacement Cost, Shadow Project, and Environmental Annuity Approaches

The replacement cost approach seeks to determine the costs that would need to be incurred to replace damaged or destroyed natural capital. The shadow project approach involves determining the costs of designing, implementing and operating a project which would provide the same environmental functions as that part of natural capital that the analyst seeks to value (Lutz and Munasinghe, 1993:203). The environmental annuity approach is based on the assumption that the public can be compensated for the loss of environmental services provided by natural capital through the provision of additional services of the same type in the future by artificial means for a number of years until the public is "paid off" for the loss of service. The value of the natural capital in question becomes equivalent to the cost of creating or restoring the appropriate amount of ecological capital for the required time period (see Unsworth and Bishop, 1994). These three approaches are essentially variations on a theme, and they share common strengths and weaknesses.

These techniques are claimed to be appropriate only "if there is some compelling reason to repair the damage (Lutz and Munasinghe, 1993:203), and if "the benefits from the environmental resource are at least as great as the replacement expenses" (Munasinghe, 1993:28). The replacement cost approach is appealing from the perspective of concern for sustainability because it seeks to maintain natural capital intact: natural capital should not be depleted, and if it is depleted, it should be restored, repaired or replaced; in making decisions about natural capital, the costs of any natural capital depletion need to be taken into account. It is also appealing because it is inspired by a commonly accepted practice in business. Replacement cost was adopted as a rule to maintain capital intact and avoid distributing artificial money profits during a period of rapid inflation when replacement cost of an asset is likely to be greater than recorded book value (Bannock et al., 1991:213). When capital depreciation is calculated, replacement cost indicates to the owner of capital the cost involved in making good the capital worn out (Jacobs, 1991:233).

The replacement cost approach has been used to value the national cost of soil erosion, mainly by determining the replacement cost of artificially applying N, P, and K nutrients equivalent to those contained in the soil lost through erosion. Several problems with this approach are commonly recognized. It assumes that the application of artificial fertilizers can adequately replicate the nutrients and structure of the soil lost to erosion, that there are no thresholds beyond which soil will not recuperate, and that natural erosion and replacement rates are known (Adger, 1993:351). Where irreversible environmental damage has occurred, there is no means of repairing the damage, and hence no meaningful replacement cost can be determined (Jacobs, 1991:234). The replacement cost approach may convey a false sense of security by suggesting that natural capital can be replaced or restored, when most ecological damage is not reparable and is often irreversible (Hinterberger et al., 1997:4). Replacing forest flooded by a reservoir with a replanted forest may provide the same amount of biomass, but is unlikely to provide the same amount of biodiversity (Munasinghe, 1993:28).

The replacement cost/shadow project/environmental annuity approaches are appealing as the world presses against ecological limits, in that they are based on a presumption that there should be no net loss of natural capital, as that which is destroyed should be replaced. However, this appeal is somewhat weakened, as these approaches allow for monetary compensation for the loss of natural capital: there is no guarantee that the replacement or shadow project will go ahead. In application, further weaknesses are revealed: bags of fertilizer make poor substitutes for topsoil, and there is likely to be loss of natural capital as the extraction, manufacture and transportation of the very replacements, e.g. fertilizer, imported to make up for soil loss may themselves have contributed to soil loss and global warming (Hinterberger et al., 1997:9). The costs of this second-order natural capital depletion are likely not included in the costs of materials needed to restore the natural capital subject to analysis, and hence the cost of restoration will be understated.

Determining replacement costs also depends on what level of environmental function will be acceptable as a substitute. Artificial wetlands poorly substitute for existing wetlands. Furthermore, the land which is to be transformed into wetland to compensate for wetland destruction is likely to have been performing environmental functions of its own, which will be lost as a result of the transformation. To be consistent, this loss would also have to be replaced. Many proposed substitutions need to be carefully scrutinized: tree plantations do not substitute for old growth forests, just as paint and canvas and a week's wages for a painter are no substitute for Leonardo da Vinci's *Mona Lisa*. Yet applying replacement costs to a strict ecological standard, e.g., where costing is based on maintaining high levels of environmental function, does not solve the analyst's dilemma, as it would generate a near infinite value for most forms of natural capital. What is the analyst to do with such numbers?

The shadow project approach, if widely applied, involves a fallacy of composition. For instance, consider a shadow project designed to replace the ecological functions provided by old growth forests. One means of replacing old growth forest slated for logging would be to buy up and set aside an appropriate area of mature forest and to allow it to reach old growth status. The cost of this land purchase would then approximate the value of the old growth. However, if instead of merely ascertaining market prices for mature forests, actual purchases were made each time old growth was to be liquidated, the value of mature forest would rapidly escalate.

The approaches considered in this category are rejected for application in BC's MAA framework. This is because there is either a tendency in past application of these methods for analysts to obtain values from projects which do not adequately compensate for the loss of natural capital, or for this approach to generate near infinite values for natural capital. While the latter outcome could support decisions which were strongly sustainable, in the current political context the use of infinite values for all but a few critical components of natural capital is more likely to result in the analysis being ignored.

1.13.4 User Cost Approach

El Serafy turned for inspiration to accounting methods used by mining and petroleum industries to record the depletion of their reserves on their balance sheets. He also drew on Hick's suggestions for income estimation (El Serafy, 1981). His method is based on a couple of conceptual arguments:

- sales of assets do not generate value-added, and should not be included as income at all, but rather as asset substitution (El Serafy, 1993:250).
- there is an intertemporal opportunity cost associated with using up a depletable resource. A barrel of oil used today cannot be extracted tomorrow.
- depletable capital cannot be maintained if it is to be used at all, and hence the accountant accepts that there is no need to maintain this capital intact (El Serafy, 1993:247).

Hicks had suggested that income from a wasting asset could be estimated by calculating what permanent income stream could be generated by investing the proceeds. El Serafy proposed that the analyst adjust income from depletable resources by subtracting the user's cost. The user's cost is that proportion of the proceeds from the sale of a depletable resource that should be reinvested in order to provide for an equivalent income to the asset owner once the asset is depleted (El Serafy, 1993:256). In order to make this calculation, one needs to know the life expectancy of the resource, as well as to select a discount rate for the analysis. Life expectancy is calculated by estimating the ratio between total reserves and current extraction.

The user cost method, at least as applied to depletable resources, had the personal approval of J.R. Hicks (van Dieren, 1995:201, fn. 14), whose definition of income underlies much of the basis for this study, so in this sense it is attractive. It also does not require that one value the total stock, nor do windfalls or changes in stock assessments produce volatile results which lead to misleading signals or contamination of the income figures with wealth valuations (El Serafy, 1993:254). It has been applied in many different studies (van Dieren, 1995:201; El Serafy, 1993:252, fn. 8), and it has been modified as a tool for application at the project level (Mikesell, 1992).

Initially, El Serafy intended that his formula be applied only to adjust income derived from depletable resources. He was clear in bounding his argument to exclude renewable resources being extracted at unsustainable rates (El Serafy, 1993:246). Since then, he has apparently acceded to its use in renewable resources accounting. In the Club of Rome's recent report on national accounting, in which El Serafy was involved, it is argued that

> ...the same user cost approach...is perfectly applicable to renewable resources. If exploitation of such resources is kept within their regenerative capacity, then no income adjustment will be called for--what comes out of the resource is income. But where exploitation exceeds this capacity and results in mining the renewable resource, a user cost for any such mining should be estimated by the same method, to be reinvested so that the income from the activity can be sustained (van Dieren, 1995:203).

In applying this method to renewable resources, the analyst must determine the remaining lifespan of the resource at current, unsustainable extraction rates. Yet herein lies a contradiction. This method was premissed on the fact that there is no injunction to maintain depletable resources intact, whereas a full world clearly implies a need to maintain most forms of remaining natural capital intact. When a mine is depleted, it is one thing to lose a given stream of income, or the capability to utilize this resource in the future. A prudent country will have invested the proceeds in a form of heritage fund, and will likely be better off than if it had acted as a spendthrift and used all the proceeds to finance current consumption. Yet the level of ecological function may not have changed significantly as a result of the mine's exhaustion. In the case of forests mined to depletion, the loss of future timber flows will cause economic hardship, and a country would have been better off investing the proceeds in a heritage fund, than merely spending all the proceeds at once. But whether the proceeds were kept as a capital fund or spent would be a moot point. Either way, a country which depletes forests will experience lasting hardship as mountainsides become prone to landslides, as the local ecology and climate changes, and as local ecological functions are greatly diminished. El Serafy's method does not ensure that such linkages will be taken into account. It takes the perspective of a single resource owner (e.g., the owner of the rights to extract timber) rather than taking the perspective of a society deriving both commodities and benefits in the form of ecosystem services.

To apply the user cost method to renewable resources, one must also determine when exhaustion is deemed to occur. The simplest answer in the case of forestry is when there is simply no more timber to be extracted. However, there are other thresholds that could be selected. At a certain point in the liquidation process, further extraction may become financially unattractive to the exploiter, if remaining timber densities are too low, or if standing timber is located in difficult terrain and/or in more remote areas of the landscape, make extraction and transportation costs prohibitive. There are also points at which the forest ecosystem will go through irreversible changes, and at which the prospects for future, sustainable extraction regimes may be greatly diminished. These thresholds are difficult, if not impossible, to predict. There are other differences of perspective. Only a decade or two ago, BC's deliberate policy of liquidating old-growth stands and replacing them with managed forests was commonly accepted as wisely investing in the future productivity of the forest.

One solution which suggests itself in the latter case is to compare the current AAC with the LRSY, and the number of years until fall down as the life expectancy of old growth, while assuming that once old growth is depleted the LRSY can be maintained. A simple example will illustrate this concept. If the AAC is 100 000 m^3, the LRSY is 60 000 m^3, and falldown is predicted to occur in 40 years, then total receipts need to be adjusted as follows:

$$\begin{aligned}\text{Amount AAC is above LRSY} &= 100\,000 - 60\,000\\ &= 40\,000\end{aligned}$$

All revenue from the first 60 000 m^3 extracted in the current year is appropriately deemed income, as there will supposedly be a perpetual harvest at this level. To the revenue from the remaining 40 000 cubic meters, we apply El Serafy's formula:

$$\text{True income} = \text{receipts}\left(1 - \frac{1}{[1 + r]^n}\right)$$

where n = years to depletion and r = discount rate. Using discount rates of 2% and 5%, and assuming that depletion occurs in 40 years, we obtain user costs of 45% and 14% respectively. In other words, at a 2% discount rate, 45% of the revenue from the extraction levels above the LRSY should not be deemed income. In the above case, out of the total revenue generated by cutting 100 000 cubic metres, 23% of the proceeds would need to be set aside and invested to provide for continuity of revenue flows. If the extraction regime were modified such that falldown does not occur for 80 years, and if a discount rate of 5% is used, that portion of the AAC which exceeded the LRSY would only need to be adjusted into a 2% user cost stream for reinvestment, while 98% would be deemed revenue. Further, it should be noted that since the user cost method seeks to provide sustainable income flows to the resource user, extraction costs are deducted in calculating receipts. Thus a stand providing important ecological services, but near the margins of profitability for timber extraction, would according to this method have a very low value as natural capital. The adjustment generated by the user cost approach for natural capital depletion is rather minor, and is likely to have a trivial influence on encouraging more sustainable extraction regimes, while grossly undervaluing the ecological loss that is being allowed to occur. That portion of exploitation which is above sustainable rates diminishes the forest's ecological integrity, and hence it is possible that not only will the depletion stream of benefits end, but the sustainable stream will be jeopardized as well, to the point where there may be no income from the forest-based extraction at all.

Despite the enthusiasm of advocates of this approach, it is of limited appeal for use in the evaluation of forest land use options. It is a model which was specifically developed for depletable resources, whose exhaustion does not cause cascading ecological effects and degradation. It is a relatively trivial matter to estimate the rate of exhaustion for a non-renewable resource by taking current extraction rates and known reserves. By contrast, the rate of exhaustion of a renewable resource is difficult to determine. The user cost method is based on the value of commodity flows, and fails to take into account the value of other ecological functions provided by a given stock of natural capital. It is highly sensitive to the discount rate selected. When applied to renewable resources, it is based on the presumption that there are substitute projects involving investment in renewable resources able to generate equivalent income flows. However, most renewable resources are already near their limits of exploitation, and hence ill-suited to investment oriented toward increasing yields, while returns from investments in restoration activities are likely to be much delayed, and in many cases may not produce marketable commodities (e.g. restoring sub-alpine forest that never should have been cut in the first place).

1.13.5 Depreciation/Net Price Approach

The depreciation approach is advocated by Repetto and has been applied to account for natural capital depletion in Costa Rica and Indonesia (Repetto, 1992; Repetto et al., 1989). Repetto argues that the national accounts need to include a depreciation account "to reflect the fact that unless the capital stock is maintained and replaced, future consumption possibilities will inevitably decline" (Repetto et al., 1989:4). Drawing on parallels with business accounting, where manufactured capital is seen as income-producing, and depreciation of manufactured assets is written off as a charge against production, depreciation of natural capital is treated in much the same way. The entire proceeds from the sale of non-renewable natural resources are deducted from the national accounts. The argument is that the GNP currently shows the sale of natural resources as income, whereas in fact one form of asset, say, oil, has been exchanged for another, such as cash. This conversion does not represent true income, and by deducting the value by which the asset has depreciated one arrives at the correct estimation of income:

> Logically, if a country's balance sheets at two different times indicate that an asset--say a forest--has been depleted, then the income and product accounts for the intervening years should show a charge for the depreciation. This follows from perhaps the most fundamental identity of accounting: the difference in stocks between the two temporal points equals the net flow in the intervening period (Repetto, 1992:96).

These authors draw on business principles to argue that a sustainable income concept should go beyond current earnings to include changes in asset value, due to capital gains, capital losses, or stock revaluations. Much as an individual whose assets increase in value can benefit from an increase in future income, so too can a country.

Referring to the acceptance by the US accounting profession of the net price approach to account for depletion of oil reserves, Repetto begins from the principle of economic rent. To calculate the appropriate amount of depreciation, Repetto argues that, because resource owners can choose to hold or sell their stocks of natural resources, the rent of a resource tends to reflect present value of expected income net of exploitation expenses. This allows one to determine Hicksian, or sustainable, income. To apply the net price method, natural resource stocks are multiplied by their net price (the difference between the market price of a resource and its cost of extraction), at the beginning and end of the accounting period, the difference between the two being the deduction that must be made from GNP to account for depletion (Peskin and Lutz, 1993).

El Serafy strongly disputes the depreciation approach. His first three reasons apply only to the application of this method to non-renewable capital (see El Serafy, 1993:247), and are not of interest to the present study. But a number of his criticisms are vital.

First, El Serafy notes that stocks of natural capital are typically of a higher order of magnitude than annual extraction (El Serafy, 1993:249). As noted earlier, because this technique incorporates stock revaluations in the income account, the signal given by the adjusted measure becomes seriously contaminated. A country could be mining its forests to extinction, but if market prices for timber are increasing, the value of the remaining forest might appear to grow even as the forest shrinks. Decision makers could erroneously conclude that the forest was subject to effective stewardship. Secondly, reserves, be they oil deposits or forest inventories, are often re-estimated, and such re-estimation can lead to anomalous results such as net income being greater than gross income. As well, for economists sales of assets do not involve value-added, and hence should not be included in the category of income, even if it is labeled gross (El Serafy, 1993:250). Finally, as all proceeds from exploitation are deducted from gross national income, the depreciation approach suggests that there are no advantages to a country owning a large stock of non-renewable capital (El Serafy and Lutz, 1989). Clearly, this contradicts common sense.

Users of the depreciation approach rely upon various techniques to estimate the value of depleted natural capital in order to effect the required deduction from gross income. While market prices can be used for valuing the depletion of oil and gas reserves, and market values are available for timber, the analyst must rely upon other techniques to estimate the depreciation involved in phenomena such as soil degradation. In such instances, Repetto et al. advocate determining the present value of the expected future income stream that will be provided by the resource. When applied to the BC forest industry, the depreciation net price method would tend to produce very low values for natural capital, for a number of reasons. First, very little timber is traded in open markets in BC, and as a result of limited competition and vertical integration, timber prices are generally depressed from their true market value (Smith, 1997). Timber companies will often extract timber where the value of the timber is less than the costs of extraction, and the use of the net price method in such an instance would suggest that the value of such natural capital is zero or negative. This in spite of the fact that a forest is more than the sum of its trees seen as timber. This approach attributes no value for the other services provided by a forest, even though the ecological and economic consequences of degrading a given ecosystem could be much greater than the economic rent involved. Given increases in the value of timber over the last century, the depreciation/net price approach may show the value of BC's natural forest capital to be higher than it was when exploitation began in earnest, clearly a nonsensical result which would fail tests of sustainability.

Thus, the depreciation approach will tend to understate the value of lost natural capital where that capital provides important but non-marketed ecosystem functions. It also creates a signal that is so contaminated by market fluctuations as to bury warning signals of unsustainability.

1.13.6 Hueting's Sustainability Standard/The Avoidance Cost Approach/ Maintenance Cost Approach

Hueting argues that it is impossible to construct shadow prices for environmental functions that are comparable with market prices (Hueting, 1991:200), yet such shadow prices are necessary to effect the appropriate corrections to national income accounts. Instead of turning to contingent valuation or hedonic pricing methods to develop a demand curve for environmental functions, Hueting argues that the amount to be used in correcting the national accounts should be determined on the basis of estimates of the cost of meeting socially-defined standards for environmental functions. These standards are based on the requirements of achieving sustainable development, given that most developed nations have committed themselves to this objective (Hueting, 1991:204). Hueting specifies that only expenses for primary measures directly necessary to meet such standards should be used to determine the correction amount. Secondary measures, such as expenditures necessary in order to make a more stable social environment during the difficult transition period, should not be counted (Hueting, 1991:208 fn. 13).

Hueting's approach is, for all intents and purposes, identical with the avoidance cost approach, advocated by Daly, Ekins, and others, where national income is adjusted by the amount that it would take to achieve environmental sustainability (von Weimer, 1996:275). This approach is also put forth as the maintenance cost approach in the UN handbook on National Accounting, as one of the recommended means of adjusting the national accounts:

> Maintenance costs are the additional imputed costs that would have been incurred if the domestic economic activities of an accounting period had been modified or their impacts mitigated in such a way as not to have impaired the long term quantitative and qualitative levels of the domestic and worldwide natural environment (UN, 1993:105).

The UN handbook argues that if strong sustainability is the relevant criterion to apply to the valuation of natural assets, then the use of such assets should incorporate the costs of fully maintaining them (UN, 1993:18). These approaches are sometimes seen as taking a "responsibility" point of view: the current generation has a responsibility to pass on intact natural capital, regardless of current economic pressures, priorities or consumer preferences (von Weimer, 1996:274). Because this technique provides a measure of the divergence between current and sustainable practice, it provides useful signals to a society intent on strong sustainability.

The UN handbook suggests that there are five categories of measures which could be taken to prevent environmental degradation, from which the analyst can determine the appropriate connection:

> a) Reduction in economic activities or complete abstention from specific activities;

> b) Substitutions among the outcomes of economic activities, that is, production of other products or modification of household consumption patterns;
>
> c) Substitutions among the inputs of economic activities, without modifying their outcomes (outputs), *inter alia*, by applying new technologies;
>
> d) Activities to prevent environmental deterioration, without modifying the activities themselves (for example, by end-of-pipe technologies);
>
> e) Restoration of the environment and measures diminishing the environmental impacts of economic activities (UN, 1993: 108).

The maintenance cost approach has the unusual implication that if meeting the sustainability standard costs more than the value of the output, then one deducts the entire value of the output, as it would be cheaper for society to forgo the output rather than to abate the pollution. One question not addressed in the literature is how to deal with the case where meeting the sustainability test is cheaper than current practice, as many sustainability advocates argue is often the case. Would one then adjust GNP upwards? However, given the divergence between the existing economy and the requirements for strong sustainability, prices are, in effect, in disequilibrium, and the adjustments required under the maintenance cost approach are likely to greatly reduce net income, if not in many instances eliminate income altogether.

Although Hueting, Daly and the UN advance arguments to suggest that the sustainability standard-based approach can be used to adjust income derived from unsustainable extraction of renewable resources, it is not clear how the analyst ought to proceed. In the case of forests, Hueting proposes that one define the bounds within which a forest can be exploited while ensuring that the flows and services from the forest will be sustained. Then, the estimated expenditures on the measures required to meet those standards "tells us in monetary terms how far a nation has drifted away from its standard of sustainable use of its forest resources" (Hueting, 1991:206). If current use of the forest meets a strong sustainability standard, then there is no cost involved in meeting the standard, capital is not depleted, and there is no charge set against income account. In such a case, all income derived from forest exploitation is true income.

Hueting's claims to the contrary, it is not obvious how to proceed when renewable resource use is unsustainable. Hueting reviews an example from Indonesia, where the intent is to derive the adjustment necessary to account for high rates of soil erosion. Hueting first identifies measures which will bring erosion back down to the natural rate. These measures include reforestation, terracing, rebuilding roads, drainage and irrigation systems, public education, and installing officials (Hueting, 1991:208). Yet turning to the case of the BC timber industry, what primary expenditures would be necessary to ensure that the forestry industry meets a sustainability requirement? A variety of direct measures could be considered by the analyst:

i) Determine the level of compensation necessary to get tenure holders to voluntarily reduce the rate of cut and to adopt the techniques necessary to meet the sustainability standard;

ii) Calculate the costs of ecological restoration if cutting does go ahead--which means that a replacement cost approach is involved;

iii) Count the costs of shutting down timber extraction in future periods for the length of time required for natural growth to rebuild the forest capital depleted in the current period. This becomes similar to a change in productivity approach;

iv) Count the costs of buying an equivalent amount of private forest to be set aside for protection in order to compensate for the loss of natural capital and ecological services (assuming that the private land was slated for unsustainable logging). This becomes equivalent to the compensatory project approach;

v) Count the cost of passing legislation to compel timber companies to meet the sustainability standard. This cost could be very low: the cost of hiring a lawyer to draft the bill, and the printing and promulgation costs. Or, it could be very high, if the government is sued for compensation;

vi) Hueting suggests deriving costs based on the costs of cutting trees selectively and applying reforestation. The intent here is obviously to obtain costs by looking at the costs of a sustainable operation, though the operation Hueting suggests as a baseline might better be characterized as benign plantation forestry, unlikely to be sustainable over the long term, rather than ecoforestry. Even so, it is not clear how this approach would work: the costs of logging an equivalent AAC in an ecologically sustainable manner might well be less than the costs associated with industrial forestry. For instance, ecoforestry usually does not rely upon site preparation, treeplanting and other intensive silvicultural methods, as it attempts to encourage natural regeneration and focuses on maintaining the intact forest stand. Hueting's suggestion could even lead to a perverse result, as an ecoforestry approach could conceivably be cheaper than the industrial approach, if full cost accounting is used and the time frame is specified as one complete rotation. Income flows derived from unsustainable industrial forestry would then be adjusted upwards according to this technique, a clearly absurd result. Yet Hueting himself in an entirely different context argues that there are many instances in which the more ecological approach is cheaper than the unsustainable status quo (Hueting, 1996).

vii) In the rare circumstances where extraction takes place at a rate lower than the sustainability standard, the relevant investment in natural capital would be determined by reference to the revenue that could have been obtained by increasing extraction up to the sustainability standard. However, not all of this capital could be appropriated at a later date by humans, as trees in an old growth forest must be allowed to die and decompose, and at a certain point an old-growth forest can be seen as reaching a steady-state where no further capital is accumulated, or where capital is accumulated very slowly.

The maintenance cost approach is appealing from the perspective of this study because it is derived from a commitment to strong sustainability and fits a Hicksian understanding of income. At the same time, it is impractical and arbitrary, and the output is highly dependent on which measures the analyst deems necessary in order to meet the sustainability standard. Extensive research and modeling would often be required to determine the appropriate adjustment. Therefore, the maintenance cost approach will not be recommended for use in adjusting BC's MAA system, but this study will draw on Hueting's overall argument and approach for inspiration.

1.13.7 Generational Ecological Debt Approach (GED)

While not advocated as a means to adjust the national accounts, this approach by Azar and Holmberg (1995) is a creative response to dealing with one problem in natural capital valuation: namely, that much ecological damage is irreversible and/or irreparable. The GED is defined as the sum of, first, the cost of restoration measures, where restoration is feasible and where the benefits of restoration exceed the costs; and, second, the social costs of the remaining, unrestored damage.

In the case of unsustainable forestry, restoration costs would be those measures which were cost-effective. Thus the analyst would include the costs of replanting, counteracting soil erosion, adding large woody debris and creating artificial snags in clearcut, etc., and each of these measures would be applied to the extent that it provided a payoff in terms of future productivity and avoided damages. This would still leave much damage unrestored, as restoration measures which did not provide net benefits would not be undertaken. The cost of unrestored damage would be the present value of damage attributable to industrial forestry practices that is expected to result despite the implementation of cost-effective restoration, but not total restoration. Of course, estimating such costs would be very difficult, though a rule of thumb approach might prove workable. For instance, the analyst could determine the cost of cost-effective restoration measures, and multiply this figure by a certain factor to take into account unrestorable damage. Such rules of thumb might be determined by case studies, or could be set by convention.

Where industrial forestry would entail extensive ecological degradation, it is very likely that the total costs attributable to industrial forestry using this approach would greatly exceed the value of the timber extracted in the first place. This method would therefore send a signal conducive to strong sustainability by suggesting that such timber is better retained for its contribution to well-being as standing forest. However, because this method concentrates on social damages, it would suggest that the depletion of natural capital in a densely populated valley would have a much higher cost than the depletion of natural capital in a pristine valley (as there would be more people suffering damages in the former), despite the fact that the latter might be ecologically more important. This problem could be reduced if the analytical perspective were at large regional scales over long time frames, such that the costs of unsustainable forestry would include damage to the fisheries and reduced productivity of the larger landscape.

This approach requires too much analysis to be recommended for use in BC's MAA system. It is also likely to generate values for natural capital depletion that would be so high as to cause the approach to be dismissed. However, it is an approach that could be used in a few case studies as a point of comparison with whatever method is eventually used, and in order to refine the technique.

1.13.8 Ecosystem-Economy Linkages Approach

Rather than assign a value to natural capital depletion, many researchers have attempted to more accurately model the linkages and dependency of economies upon local ecosystems, such that the economic impacts on the economy of ecological change become more apparent to decision-makers and to those who will be most affected by the change. Such modeling techniques range from identifying a few, key linkages and making reasonable assumptions as their importance or strength, to sophisticated ecological modeling. In an example of the former, Ruitenbeek modified a standard cost-benefit analysis to reflect interactions between various aspects of a mangrove ecosystem threatened by clearcutting, the coastal fisheries, and traditional uses of mangrove resources (Ruitenbeek 1991; Ruitenbeek 1994). Interactions were either direct or indirect, linear or catastrophic.

Winter (1995) uses input-output analysis to integrate natural resource accounting with conventional economic accounting by using capital investment theory, as developed for dynamic input-output models, to examine the economic implications of natural capital depletion by a proposed year-round resort in Colorado. However, in order to subtract natural capital depletion from conventional measures of economic wealth, coefficients specified in the model to indicate consumption levels of natural capital must be monetized (Winter, 1995:22). This brings us back to the problem of natural capital valuation, resulting in a circularity. The study also makes assumptions which are on shaky ecological and economic grounds, such as categorizing "below cost" timber sales for habitat improvement and fire danger mitigation as capital investment (Winter, 1995:32). The I-O model requires that an explicit relationship between economic production and natural capital consumption be defined. Many relationships could not be specified, such as how habitat destruction will affect local threatened and endangered species. The resultant matrix of natural capital flows is mostly blank, introducing the potential for "serious bias" in the model (Winter, 1995:47). Disaggregated coefficients for different sectors are often derived from the same initial aggregated figures, limiting the conclusions that can be drawn from comparing natural capital flow coefficients between sectors (Winter, 1995:48). Winter concludes that such modelling can "yield useful information not available from any other source," and that it demonstrates that accounting for natural capital stocks and flows is relevant to regional wealth calculations (Winter, 1995:61-62). Yet for all the effort involved, the circularity, the number of assumptions required, and the difficulty of defining natural capital flow coefficients, Winter's approach is still too tentative for widespread application.

As an example of sophisticated ecological modeling, Ulanowicz has advocated the contributory flow analysis technique which draws upon ecological modeling and input-output analysis, to determine the relative contribution of different ecosystem inputs to final products utilized by humans. Ulanowicz cautions that using the contributory flow analysis to determine the contribution of trees to pelt production in a given bioregion, "does not assess the value of trees in creating habitat for mammals, nor does it begin to encompass the host of other roles...that trees play in the ecosystem" (Ulanowicz, 1991:266). Ulanowicz does argue, however, that it may help politicians and the public to appreciate better the value of unrecognized ecosystem components. As an example, he refers to an analysis in which it was found that the cilate population of the Chesapeake Bay, a component of the Bay ecosystem that most Bay residents may not even know exists, contributes 35 units to every 100 units of the valuable striped bass fishery. According to Ulanowicz, calculating the contributory values of ecosystem components provides at least a conservative estimate of the value of the underlying ecological foundations of a given resource (Ulanowicz, 1991:266).

The first step, when using the ecosystem-economy linkages approach, is to develop a model of the linkages between the ecosystem and the economy (a contributory flows analysis would take a different approach, see Ulanowicz (1991) for a detailed description). Thus, for the Slocan Valley, linkages between clearcutting and water quality, quantity and timing of flow would be established in order to understand how clearcutting will effect market and subsistence agricultural production, as well as domestic water supplies. This would be done for each sector of the economy and for each major ecological function. Linkages beyond the local economy, to the regional and at least provincial economies, should also be established. The ecological changes resulting from a failure to adopt sustainable forestry would then be modeled. The analyst then has two choices. Natural capital could then be valued in terms of the change in NVP of resource flows and services provided by natural capital before and after depletion (though this would still not resolve many of the problems associated with valuation). Alternatively, natural capital valuation can be omitted and the analysis instead concentrates on changes in resource flows and economic activity that are fed directly into the multiple accounts analysis. Less information is lost because valuation is not used to adjust economic analysis; rather, the economic analysis itself is modified.

An important advantage of this technique is that it attempts to assess the economic consequences of stressing ecosystems and depleting natural capital, as they are likely to be experienced, rather than by concentrating on correcting the books. It may be that humans give little value to the cilates of Chesapeake Bay, until they understand how their commercial and recreational fisheries depend upon them. Ideally, this approach would provide a better picture of the ecological and economic consequences of logging the Slocan

Valley's watersheds. If adopted in BC's MAA framework, it would correct for the current lack of connection between the environmental and economic accounts. At present, the economic account can show an option as producing significant economic benefits, all the while the environmental account identifies serious environmental change. Such divergence is unrealistic.

While this approach offers significant advantages by attempting to model economic-ecological linkages, it has several limitations. Because it traces dependence between current economic activity and ecological function, it would fail to capture the value of many ecosystem functions that do not result in marketable economic activity, though it may do better than most approaches in this regard. Developing a model which effectively captures the linkages is difficult, time-consuming and expensive. If sophisticated models cannot be made, then interaction will have to be specified on the basis of rough estimates and professional judgment. Given that MAA in BC is supported by Resource Appraisal, a commitment to model such impacts, at least coarsely, already exists. By putting more effort into resource appraisal, and specifically into identifying economic-ecological linkages, and then building in linkages between the environmental and economic accounts, MAA could be much improved.

1.13.9 Valuation of Ecosystem Services in the ISEW

In their work to adjust GNP to create the Index of Sustainable Economic Welfare (ISEW), Daly and Cobb (1994) deduct from the GNP the value of lost wetlands, based on the value of the flow of services that a wetland provides. Daly and Cobb note that the loss of the stream of benefits provided by a wetland is cumulative--if y hectares of wetland are lost each year, then by the second year the total value of lost wetland services is equal to $2y$ times the average value of wetland services per hectare. Furthermore, Daly and Cobb argue that as more wetlands are destroyed, the value of the marginal hectare destroyed increases.

Daly and Cobb derive their figure by reference to figures quoted in the literature, and increasing the value by one-third to account for the consumer surplus that was not estimated in the study in question. Therefore, there remains the problem of choosing either a study in the literature or a basis to value the services provided by a given hectare of forest. Hence, this approach ultimately relies on one of the other techniques reviewed in this subsection, and therefore does not help identify a solution to the problem faced by this study.

The cumulative loss of service and increasing marginal costs of destruction, that Daly and Cobb argues applies to wetlands, may or may not apply to forests. For instance, clearcutting an alpine forest where regeneration is extremely difficult may be considered to result in the permanent loss of most ecosystem services provided by the stand; likewise for a five hundred year old stand of old growth valley bottom forest rich in biodiversity and ecological legacies. Then again, in the better growing conditions of a valley bottom site, a certain proportion of ecosystem services could be restored within a couple of decades. Often the first stands to be cut have the most old-growth, are the most productive, and are the most accessible, and therefore the value of lost services would be high. Next, cutting often occurs in more marginal stands, and the services lost might well be of lower value. However, as the best stands of timber are depleted and extraction moves to the steeper slopes, and up into the headwaters of watersheds, the services lost could be very significant. As more of the forest disappears, the value of the marginal hectare cut would increase, until the point at which some form of ecosystem collapse occurs, and at which point further cutting may result in very little reduction in ecosystem services.

The most reasonable means of simplifying all of these complicating factors would be to set an arbitrary though defensible value for the ecosystem services provided by various forest ecosystems under a range of conditions. If one adopts the perspective of ecoforesters, the value of ecological services for a stand of timber would likely be such that the NPV of such services is significantly higher than the market price of the timber that could be liquidated from a site. Industrial forestry would be considered to destroy, for a period at least, the capability of the stand to provide ecological services, while ecoforestry properly carried out would be considered to maintain ecosystem services. This would ensure that the appropriate signal was provided to encourage maintenance and investments in natural capital.

Proxies for the value of ecosystem services provided by various types of BC forest stands in various ecological conditions could be identified through case studies. After this initial investment in research, the analyst could look up the values most appropriate for the given scenario, and the analysis would be straightforward and not demand much effort. However, because no such proxies currently exist, this method is not recommended for application in BC's MAA.

1.13.10 Valuing Natural Capital Using Contingent Valuation and Hedonic Pricing Techniques

Environmental economists argue that natural capital can be valued by constructing artificial markets through contingent valuation methods (CVM) or by referring to actual markets and using hedonic pricing methods (see Pearce and Turner, 1990:143-156). The former techniques basically involve determining what people are willing to pay to protect a given environmental feature, or willing to accept in compensation for its destruction. The hedonic price method relies on observed market prices and statistical analysis to determine how much of a price differential for similar goods or experiences is due to differences in environmental quality. From this basis, the value of a given level of environmental quality or the value of a given environmental feature can be determined.

There are a number of criticisms of the contingent valuation approach. For instance, Schkade and Paine (1994) studied the reasoning process respondents used in contingent valuation studies, and concluded that the responses had little to do with the values which economists were seeking to determine, such that economists are unlikely to be "measuring what they are supposed to be measuring." Answers have also been shown to depend on whether the question is embedded: is the environmental feature considered on its own or as part of a package (Kahneman and Knetsch, 1992). For instance, the value of a lake as given by CVM may depend on whether one asks first the value of all lakes and then the value of a specific lake, or the value of a specific lake directly. Answers have also varied depending on the order in which questions are asked, whether complements or substitutes are valued at the same time (Samples and Hollyer, 1990), the frame of reference in which the question was asked (Tversky and Kahneman, 1981), and host of other arbitrary factors. Two reviewers of the method have concluded, "...contingent valuation is a deeply flawed methodology for estimating resource values, one that does not estimate what its proponents claim to be estimating" (Diamond and Hausman, 1994:62).

Other critics have attacked the deficiencies of the utilitarian and efficiency-driven underpinnings of the CVM approach (Sagoff, 1994a, b). Yet most welfare economists do not acknowledge that "the identification of well-being with the satisfaction of preferences is a controversial ethical judgment" (Hausman and McPherson, 1996:44). Both CVM and hedonic pricing methods accept the current distribution of wealth and entitlements, leading to valuations which are highly prejudiced against those who are poor or who are marginalized by the economy (Bromley, 1991). Finally, if society seeks a sustainable outcome, it cannot turn to valuations of natural capital derived from individual choices made in the context of an unsustainable economy (Norgaard, 1989). It should also be noted that CVM relies upon the conception of humans as separative individuals, who are "autonomous, impervious to social influences, and lack sufficient emotional connection to each other to make empathy possible," a model that has been much criticized by feminist economists (England, 1993:37). Of course, this latter criticism is broadly applicable to economic theory in general.

The hedonic price method is only applicable in those instances in which a given environmental feature, such as air quality or proximity to a park, results in differences in the market prices of a good or service affected by the feature in question. It can be used to determine how air quality affects housing prices, but it would be difficult to argue that differences in housing prices could be used to determine the differences in value between an intact ecosystem and one that is going to experience unknown amounts of ecological deterioration over the next few decades.

In the context of this research study, there is a more compelling reason to reject the contingent valuation and hedonic pricing methods. In Chapter 3, it was established that from both the economists' understanding of income and from recent societal commitment to sustainability, that there is a need to ensure that economic analysis incorporates the need to maintain natural capital intact. Valuations of natural capital based on a CVM or on hedonic pricing methods are fraught with ecological ignorance and short-term perspectives, and are strongly shaped by current entitlements, etc., such that applying such valuation would not result in the necessary signals in order to achieve ecological sustainability. Dore draws on Marshall's observation as to how demand influences short term prices, but over longer periods, the costs of production predominate in price formation, to argue that the value of a forest is not willingness to pay or willingness to accept compensation,

> ...but rather the social opportunity cost of the forest: what it would mean to society if the forest were not there. For instance, it may mean a larger concentration of carbon dioxide in the atmosphere, increased soil erosion and loss of plant and animal biodiversity, etc. ...[WTP and WTA] value determinations are inadequate because the

> consumer has little or no information [regarding] the innumerable functions that forests fulfill (Dore, 1996:68).

Once one moves away from the economists' rule of bringing analysis to bear upon the goal of individual utility maximization, to incorporate such goals as sustainability, then the basis for valuation changes. As Costanza and Folke (1997) argue, "...if the goal is sustainability, one should assess value based on the contribution to achieving that goal--in addition to value based on the goals of individual utility maximization, social equity, or other goals that might be deemed important" (Costanza and Folke, 1997:49). Given that the CVM and hedonic pricing methods are controversial, conceptually dubious, and do not contribute to the goal at hand, they are rejected as a basis for accounting for the depletion of natural capital.

1.13.11 Stumpage, Rent and Tenure Based Valuations

The BC Forest Resources Commission sought to determine the value of timber in BC's commercial forests. Two approaches were used. The first focussed on the asset value of BC's expected stream of future forest revenues, net of expenses. The second approach was based on market valuation, by applying prices observed in the Vancouver log market and reported for sales of forest tenures (Forest Resources Commission, 1991:65-68). While these valuation efforts demonstrated that the government was failing to capture adequate rent on its resource, they consider the value of timber only (see Luckert and Bernard, n.d.) They are thus of no real use in addressing either the valuation of natural capital or the treatment of a stream of benefits that is based on natural capital depletion.

1.13.12 No Adjustments Necessary

A couple of authors argue that adjustments to the GNP to account for the depletion of natural capital either are not necessary, as market prices take these effects into account, or would be too arbitrary and would contaminate the national accounts with measures for which they are not designed (for instance, see Thage, 1993).

According to such arguments, if it is publicly known that the Slocan Valley will be logged at a given rate and using industrial techniques, the real estate market will already have taken into account expected declines in environmental quality, increases in required defensive expenditures, decreases in the ability of farms to produce food, etc., through lower property prices. Making corrections to income or to account for natural capital depletion would therefore double count the problem. However, property owners may not be able to predict the full impacts of industrial logging, and generalized depletion of natural capital throughout BC or Canada would mean that these effects would not be noticed in market prices as people would have to live in a degraded landscape somewhere. Furthermore, much of the loss of natural capital is the loss of a public good which may not be captured by private property prices. Extending this argument back to the business sector would suggest that corporations should not have to account for using up their assets as investors would change their valuations of the company's net worth in any case. However, proper accounting methods clearly are necessary if the investors are to have the information they require to decide whether or not to invest in a company, or for company managers to know whether they are practicing sound management. The argument that no adjustment is necessary is therefore rejected, although it is useful to pay attention to the extent to which the market may be adjusting valuations in accordance with whether production is sustainable or not (given the stock market records set in 1997, one can conclude that market prices are not influenced by sustainability considerations).

Appendix 2: Data, Methodology, and Detailed Results of Applying the Interest/Depletion Approach

2.1 Considerations Involved in AAC Determination that Affect the Natural Capital Baseline

A review of some of the technical details involved in setting the annual allowable cut will help clarify issues involved in setting a natural capital baseline. In order to calculate an AAC, it is necessary to determine the extent of the timber land base. To do this, the Ministry of Forests subtracts certain categories of land from the total land base. These subtractions include:

- land not managed by the Ministry of Forests;
- water;
- non-forested land;
- alpine forest;
- non-commercial cover;
- inoperable areas;
- certain environmentally sensitive lands; and
- road, trail and landing areas (Ministry of Forests, 1994:4-7).

From this the timber harvesting land base is determined. By applying timber growth and yield models to this landbase, based on stand composition (the timber species at each site), site quality, and age class, a Gross (Industrial Forestry) AAC can be determined. For the Slocan Valley, SFF estimated the Gross (Industrial Forestry) AAC to be 226 000 m^3. According to SFF, the Gross AAC needs to be further reduced to obtain the Net (Industrial Forestry) AAC. These additional netdowns are required to meet Ministry of Forests guidelines and standards, "green-up" requirements (height or crown closure conditions that a new plantation must meet before it is considered to be stocked, for reasons related to water quality, wildlife habitat, soil stability and aesthetics), cutblock adjacency requirements (a given block cannot be cut until adjacent blocks meet green-up requirements), and to account for visual and wildlife management objectives.

SFF notes that the Gross AAC for Tree Farm License #3 ended up being 32% lower once such additional netdowns were modelled by the Ministry of Forests. Not having the resources necessary to do the detailed modelling required to factor in these additional netdowns, SFF had to have recourse to past experience (Jason Kubian, personal communication, October 10, 1997). SFF reasonably suggests that the conventionally determined net AAC for the Slocan Valley will be at least 25% less than the gross. The Net Industrial Forestry AAC, as calculated by SFF, becomes 170 000 m^3.

To derive the (industrial) LRSY, SFF suggests that it would be at most 50% of the net AAC, or 85 000 m^3. This is to account for Forest Practice Code requirements, and to reflect reduced productivity due to site degradation, the implications of moving from liquidation of old growth to living off the working forest, and the need to restrict logging in certain circumstances to protect non-timber forest values.

Until very recently Ministry of Forests has never made public an AAC specific to the Slocan Valley, nor has it provided detailed AAC calculations. According to Hammond (Herb Hammond, personal communication, December 8, 1996), the first time Ministry of Forests publicly committed itself to an AAC specific to the Slocan Valley was in its October 4, 1996 critique of the Silva Plan (Economics and Trade Branch, 1996:4). In this document, the AAC for the Slocan Valley is set at 225 000 and the LRSY at 174 079, based on applying timber supply projections from the Arrow TSA Timber Supply Review, to the proportion of land represented by the Slocan Valley, and adding in the AAC for TFL#3. A review of the Timber Supply Review suggests that this Ministry of Forests

AAC includes all netdowns for land not available for timber harvesting, and to take into account green-up requirements and cutblock adjacency guidelines. Special management zones are called for, which impose further restrictions on timber availability, by affecting the amount of timber that can be removed in one entry, or by imposing restrictions upon the manner in which extraction can occur. For instance, in class 1 and 2 watersheds, "the intent is to limit harvesting so that it does not detract from water quality and quantity" (ATSA, 1994:11). However, such guidelines have not reduced the intensity of extraction, and often they have had the perverse effect of encouraging industry to liquidate stands before detailed guidelines are spelled out (Burda et al., 1997:26). As protests in the Slocan Valley suggest, much of the public has no confidence that such guidelines will be effective. There is thus a substantial difference between the Industrial Forestry AAC as calculated by Silva at 170 000 m^3, and that of Ministry of Forests at 225 000.

The analysis in this study will, when referring to the industrial AAC, adopt the AAC figures generated by Ministry of Forests. This is not to reject SFF's estimates, but rather to avoid using numbers for the status quo approach that are at odds with the numbers generated by Ministry of Forests. However, either set of figures could be used to illustrate the interest/depletion approach.

2.2 Selecting the Natural Capital Baseline

Before proceeding, two observations can be made which are relevant to the discussion which follows. First, the AAC as set by SFF actually involves investment in natural capital. Over the 100 year period, society is better off, in that the income from the forest that it can sustainably consume would effectively double as a result of deferred consumption and investment in restoration measures intended to rebuild the integrity and natural productivity of the forest. Furthermore, as the rotation age is lengthened, the quality of the resource is usually improved (up to a point). The SFF ACC requires that resource users wait before extracting some of the annual increment, such that the productive stock grows (Daly, 1994:31). Secondly, the drop to the Ministry of Forests' long run AAC as a result of currently high extraction rates reflects the depletion of natural capital. Even if SFF's figures are rejected as an appropriate baseline, any economic benefits generated from cuts in excess of the Ministry of Forests' own Long Run Sustained Yield cannot be considered as income, but rather involve capital depreciation as old growth natural capital is depleted to sustain current consumption. The most economically conservative analysis would therefore at least have to make adjustments using the LRSY as the baseline above which natural capital is held to be depleted. Proceeds from such liquidation should not be deemed income.

2.2.1 Use Ministry of Forests LRSY

The long run sustained yield determined by Ministry of Forests could be used as the baseline figure. In this case, industrial timber extraction would involve depletion of natural capital for the first 100 years, but the rate of depletion would appear as relatively modest. This approach would be furthest from an ecosystem-based rationale, and it is thus the most ecologically risky. There is a high likelihood that projected LRSYs are unduly optimistic. If indeed the LRSY turns out to be too high, then during the period until this is realized and the LRSY adjusted, too much of the proceeds from extraction would have been deemed interest rather than depletion. Of course, the LRSY is supposed to factor the depletion of natural capital into account, as it attempts to project the level of extraction that will be sustainable after old growth has been liquidated and plantation forests have been established across the operable landscape. However, for reasons explored in Chapters 2 and 3, the LRSY is at odds with much of the current understanding of forest ecology. It would be appropriate, in principle, to use a LRSY, if yield would in fact be sustained without degrading forest capital conceived of more broadly.

It should be noted that even if the LRSY turned out to be indefinitely sustainable, by following an extraction regime which involved falldown to the LRSY, natural capital depletion would still have occurred. Society would be making the decision to accept the change from an ecologically healthy situation, with old growth forest and a forest supporting a diversity of functions, providing many ecological services, and producing high quality timber, to a simplified forest landscape, supporting fewer functions, providing fewer ecological services, and producing lower grade timber. It is also likely to be a more brittle forest ecosystem, requiring additional human interference and impacts in order to ensure production of desired commodities.[18] Society may indeed decide to move from higher to lower levels of natural capital, but the conscientious economic analyst should serve as a moderating influence by cautioning that the proceeds cannot be deemed income as they involve capital depletion.

Given the lack of a precautionary stance, shortcomings in how the LRSY is determined, and the fact that even if timber yields could be sustained at LRSY levels, this would be at the expense of other aspects of natural capital, such as biodiversity. The LRSY as currently set thus seems inappropriate as a natural capital baseline.

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[18] The need for increased human interference to counteract brittleness also affects the sustainability of the LRSY. For instance, the new forest landscape may require more pesticides and fossil fuels for planting, brushing, spanning and pruning operations, but this complicating factor will be set aside for the moment.

2.2.2 Use an Ecosystem-Based Long Run Ecologically Sustainable Yield (LRESY)

Given current degradation of forest ecosystem around the world, it is likely that ecosystem-based approaches, if not compromised for reasons of political expediency or to enhance social acceptability, will frequently determine that the short run ecologically sustainable yield (SRESY) needs to be lower than long run ecologically sustainable yields, until the forest's integrity and productive capacity has been rebuilt. In such circumstances, it will be necessary to differentiate between optional and required investments in natural capital. In the optional case, investment involves a decision to defer extraction now to allow even higher levels of extraction later. In the case where investment is required, failure to defer extraction to compensate for past excesses could, if the ecosystem is in a critical state, result in irreversible loss in ecosystem function and productivity. Therefore, if the analyst used the LRESY as a natural capital baseline the results could be misleading. An extraction regime which was based on applying the higher LRESY immediately, as opposed to the lower SRESY, would not be allowing the investments in natural capital on which the LRESY is based, and would therefore be depleting natural capital even though it was set as ecologically sustainable.

2.2.3 Use the Short Run Ecologically Sustainable Yield

An ecologically conservative approach is to use as baseline the current ecologically sustainable yield, assuming that this level is based on extraction levels consistent with remediating past ecological excesses. Here again, as noted earlier, the analyst faces a dilemma. The SRESY involves investments in natural capital. Quantities and possibly qualities of future timber extraction are likely to improve. However, if SFF's argument is accepted, such investments are not optional, since if they do not occur ecological integrity or health of the forest ecosystem could be compromised. In the latter case, natural capital depletion could occur. How, then, does the analyst account for extraction levels at or below the SRESY? Cautious extraction levels involve an interest stream and investment in natural capital. Yet the analyst would not want the appearance of natural capital investment in the books to invite arguments for immediately increasing rates of extraction and current consumption, since this investment is apparently non-optional from a strong sustainability perspective. At the same time, it is desirable to account for this investment to provide credit for wise stewardship.

At present, though, this dilemma is unlikely to occur. Current harvest levels are very far from either the SRESY or the LRESY, so the use of either would fundamentally change the signals given by economic analysis. The conventional LRSY, even if adopted immediately, involves natural capital depletion. The analyst faces the less pleasant task of accounting for depletion, rather than investment. Given the uncertainty involved in setting any AAC, the above deliberations are perhaps premature.

2.2.4 Use Models to Determine a Dynamic Ecologically Sustainable Yield

The most ecologically conservative approach would be to use as a baseline for analysis the AAC for any given year based on the outputs of an appropriate ecosystem-based planning model which was fed year by year extraction levels and cutting rates. If the projected cutting rate exceeds that set out by the ecosystem-based plan, changes occurring on the landscape level should be modelled and a new ecologically sustainable AAC time series projected, which would then serve as the baseline for the next year in the time series. Given the apparently large gap between conventional AACs and those derived from ecosystem-based plans, a short period of industrial timber extraction is likely to radically reduce the ecologically sustainable yield, to the point where several decades of almost no extraction might be required, creating severe economic hardships, and making detailed economic analysis redundant.

2.2.5 Use an Average Value of the Ecologically Sustainable Yield without Adjustment

A pragmatic approach might be to adopt a baseline figure for analysis based on an average value of the first few decades of the ecologically sustainable yield time series. If cutting rates greatly exceed this baseline, such that in reality the ecologically sustainable yield should drop significantly, the baseline figure used for analysis could remain unchanged on the basis that it would still work as an indicator of the type of changes required. This is because, with a large sustainability gap, it is somewhat of a moot point whether the interest/depletion ratio is 0.1 or 0.03. If and when the political will arises to adopt ecoforestry, at that time an ecosystem-based plan based on the actual condition of the forest could be used to determine the appropriate extraction rate upon which to base economic analysis.

2.2.6 Examine Past Studies to Determine the Appropriate Adjustment

The analyst has a variety of sources from which to consider how resource extraction regimes could be modified to at least slow the rate of natural capital depletion. Given that various scenarios are compared through multiple accounts analysis, and that resource appraisals are prepared in support of MAA, the analyst could seek to identify the modifications which would contribute to maintaining natural capital intact. Another source of such information are the Timber Supply Reviews (TSR) and the Rationale for AAC Determination set by the Chief Forester. For instance, the 1995 Arrow Rationale provides much evidence that the Chief Forester is favouring the maintenance of current extraction levels, even though he recognizes that several factors could imply that the current extraction levels would need to begin falling, not in seven decades as suggested by the TSR, but perhaps even *within* the decade. These factors include:

- the possibility that a four-pass or five-pass system will be needed to meet adjacency and forest cover requirements, rather than the current three-pass system;
- the possibility that harvesting constraints in Class 1 and 2 watersheds were understated;
- reductions that would result from riparian area restrictions or wildlife habitat requirements; and
- the implications of stand level biodiversity requirements (Pederson, 1995:35-36).

2.2.7 Scientific Panel Method

Ideally, the analyst could draw on the results of a broad interdisciplinary effort to define, as best as current science allows, a sustainable baseline scenario. This could be modelled on the process used by the Scientific Panel for Sustainable Forest Practices in Clayoquot Sound. Any such processes would recognize that both the science and values involved in making such a determination are contested and uncertain, while recognizing the need to define such a scenario as best as current knowledge permits. Assumptions, uncertainties and research needs would be extensively debated and documented.

2.2.8 Carry out the Analysis with a Range of Baseline Figures

The analyst could proceed by carrying out the analysis showing the results of two or more of the approaches listed above, although a modelling approach as set out in 2.2.4 might be omitted if resources for the analysis were not available. This allows those using the outputs of the analysis to engage in discussions on the appropriate natural capital baseline and to reflect on their implications.

The above discussion has proceeded with a significant simplification. Ideally, the analyst would take into account not just the AAC, but where the cut is distributed, how it is carried out, what ecological degradation is likely to result, and other indicators which have a bearing on maintaining natural capital. To do this would require that a modelling approach be used, as set out above. However, using AAC figures, but not the distribution of the cut, as a first approximation is likely to be sufficient for the purposes of characterizing the sustainability of projected streams of economic benefits, with the proviso that adjustments should be made in cases where using only the AAC fails to capture significant degradation of natural capital, e.g. the cut is concentrated in the habitat of a threatened species, or the layout of the cut will compromise key ecological functions.

2.3 Employment and Revenue Coefficients

Ecoforestry advocates argue that industrial logging techniques are both socially inappropriate and incompatible with protecting forest functioning (Hammond, 1991:242-243; Hammond et al., 1996: Chapter 6; Lansky, 92:393,400). Using less capital intensive technologies, small scale extraction techniques such as small cut teams and horselogging will result in higher employment rates than conventional grand skidding logging or skyline logging. SFF estimates that 0.1 logging jobs (exclusive of hauling) will be created per the 1000 m^3 extracted in the Slocan Valley by conventional techniques, whereas ecoforestry techniques will result in 0.5 jobs per 1000 m^3 (Hammond et al, 1996: Chapter 16, p. 18). The Arrow TSA socioeconomic analysis suggests that 0.38 harvesting jobs are created per 1000 m^3 extracted, but in this category of employment is included permit development, trucking, and road works. Horne et al. report 0.27 harvesting jobs per 1000 m^3 extracted in the interior (Horne et al., 1996:5).

This analysis is not contingent on the correct estimate of logging employment coefficients. For the purposes of the analysis, employment coefficients used in the Arrow TSA socioeconomic analysis will be used. These figures are appropriate as they include the Slocan Valley, and they are generally consistent with the values used by the MAA of the Kootenay-Boundary Land Use Plan, as reviewed in Chapter 6. For the Slocan Valley, where a scenario involves an AAC less than double that of the SFF Ecologically Sustainable AAC, it will be assumed that ecoforestry techniques are being used, and that logging employment per 1000 m^3 extracted is double that generated by conventional methods, while wages will only be 60%. This will account for the more labour intensive nature of ecoforestry extraction, and for the fact that other jobs included in this category by Ministry of Forests will not change as significantly. With respect to silviculture, it will be assumed that ecoforestry creates only half as many jobs as does industrial forestry for a given volume cut, as less tree planting and tending will be required. Nothing in this analysis addresses the issue of the employment and income effects of ecological restoration. SFF argues that investment in restoration can help provide jobs during the transition period. However, undertaking restoration would require substantial government funding. Although the long run ecologically sustainable yield is predicated on such investment, for the purposes of this analysis it will be assumed that restoration and the jobs it creates would be subject to a separate analysis. It will also be assumed that labour productivity in conventional and ecoforestry logging techniques does not change with time, despite recent experience to the contrary. This is a common and not very satisfactory simplification made in most economic analysis of forestry in BC.

With respect to government revenue, it will be assumed that total government revenue will be the same under industrial or ecoforestry regimes on a per 1000 m^3 basis. While industrial and ecoforestry regimes are likely to involve significant differences in their relative contribution to stumpage, corporate income taxes, sales taxes, personal income taxes, etc., it is difficult to determine which regime would generate more total revenue on a per volume basis. For instance, ecoforestry typically provides for higher quality timber, and thus heightens the potential for significantly higher stumpage rates, while income tax revenues can be expected to drop due to lower relative wages. Again, a more detailed analysis could fine tune this assumption, but in both scenarios a figure of $5 900 of government revenue per 1000 m^3 extracted will be used, although more detailed study could refine this figure for the different extraction regimes.

Slocan Valley Status Quo AAC

(Natural Capital Baseline Derived from SFF's Ecosystem-Based Plan)

Scenario AAC:		225,000	Nat. Cap. Baseline:		15,000
		Harvesting	Processing	Silviculture	Total
JOBS	(Full time equivalents)				
Coefficient (per 1000m^3)		0.38	0.44	0.15	0.97
Interest	7%	5.7	6.6	2.3	14.55
Depletion	93%	79.8	92.4	31.5	203.70
Total	100%	85.5	99.0	33.8	218.25
WAGES	($ in Thousands)				
Coefficient (per FTE)		48.00	47.00	38.50	46.08
Interest	7%	274	310	87	670
Depletion	93%	3,830	4,343	1,213	9,386
Total	100%	4,104	4,653	1,299	10,056
GOVERNMENT REVENUE					($ in thousands)
Coefficient (per 1000m^3)					9.87
Income	7%				148
Depletion	93%				2,073
Total	100%				2,221

Table A2.1: Interest/Depletion analysis of a Status Quo AAC for the Slocan Valley of 225,000 m^3 analyzed against a precautionary natural capital baseline derived from SFF's Ecosystem-Based Plan.

Slocan Valley Minor Compromise AAC
(Natural Capital Baseline Derived from SFF's Ecosystem-Based Plan)

Scenario AAC:		185,000Nat. Cap. Baseline:			15,000
		Harvesting	Processing	Silviculture	Total
JOBS	(Full time equivalents)				
Coefficient (per 1000m³)		0.38	0.44	0.15	0.97
Interest	8%	5.7	6.6	2.3	14.55
Depletion	92%	64.6	74.8	25.5	164.90
Total	100%	70.3	81.4	27.8	179.45
WAGES	($ in Thousands)				
Coefficient (per FTE)		48.00	47.00	38.50	46.08
Interest	8%	274	310	87	670
Depletion	92%	3,101	3,516	982	7,598
Total	100%	3,374	3,826	1,068	8,269
GOVERNMENT REVENUE					($ in thousands)
Coefficient (per 1000m³)					9.87
Income	8%				148
Depletion	92%				1,678
Total	100%				1,826

Table A2.2: Interest/Depletion analysis of a Minor Compromise AAC for the Slocan Valley of 185,000 m^3 analyzed against a precautionary natural capital baseline derived from SFF's Ecosystem-Based Plan.

Slocan Valley: Moderate Compromise AAC

(Natural Capital Baseline Derived from SFF's Ecosystem-Based Plan)

Scenario AAC: 125,000 Nat. Cap. Baseline: 15,000

		Harvesting	Processing	Silviculture	Total
JOBS	(Full time equivalents)				
Coefficient (per 1000m³)		0.38	0.44	0.15	0.97
Interest	12%	5.7	6.6	2.3	14.55
Depletion	88%	41.8	48.4	16.5	106.70
Total	100%	47.5	55.0	18.8	121.25
WAGES	($ in Thousands)				
Coefficient (per FTE)		48.00	47.00	38.50	46.08
Interest	12%	274	310	87	670
Depletion	88%	2,006	2,275	635	4,916
Total	100%	2,280	2,585	722	5,587
GOVERNMENT REVENUE					($ in thousands)
Coefficient (per 1000m³)					9.87
Income	12%				148
Depletion	88%				1,086
Total	100%				1,234

Table A2.3: Interest/Depletion analysis of a Moderate Compromise AAC for the Slocan Valley of 125,000 m^3 analyzed against a precautionary natural capital baseline derived from SFF's Ecosystem-Based Plan.

Slocan Valley Significant Change AAC

(Natural Capital Baseline Derived from SFF's Ecosystem-Based Plan)

Scenario AAC:		25,000	Nat. Cap. Baseline:		15,000
		Harvesting	Processing	Silviculture	Total
JOBS	(Full time equivalents)				
Coefficient (per $1000m^3$)		0.76	0.44	0.08	1.28
Interest	60%	11.4	6.6	1.1	19.13
Depletion	40%	7.6	4.4	0.8	12.75
Total	100%	19.0	11.0	1.9	31.88
WAGES	($ in Thousands)				
Coefficient (per FTE)		28.80	47.00	38.50	35.65
Interest	60%	328	310	43	682
Depletion	40%	219	207	29	455
Total	100%	547	517	72	1,136
GOVERNMENT REVENUE					($ in thousands)
Coefficient (per $1000m^3$)					9.87
Income	60%				148
Depletion	40%				99
Total	100%				247

Table A2.4: Interest/Depletion analysis of a Significant Change AAC for the Slocan Valley of 25,000 m^3 analyzed against a precautionary natural capital baseline derived from SFF's Ecosystem-Based Plan.

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Title of Thesis:

Accounting for Natural Capital in BC: Forestry and Conflict in the Slocan Valley

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April 24, 1998